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THE
FARMER'S GUIDE

TO

SCIENTIFIC AND PRACTICAL AGRICULTURE.

DETAILING

THE LABORS OF THE FARMER,

IN ALL THEIR VARIETY, AND

ADAPTING THEM TO THE SEASONS OF THE YEAR

AS THEY SUCCESSIVELY OCCUR.

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IN TWO VOLUMES—WITH NUMEROUS ILLUSTRATIONS.

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THE FARMER'S GUIDE

TO

SCIENTIFIC AND PRACTICAL AGRICULTURE.

PRACTICE.

SUMMER.

SUMMARY OF THE FIELD OPERATIONS AND OF THE WEATHER IN SUMMER.

2959. As spring is the restoration of life to vegetation, and the season in which the operations of the field again become active, so summer is the season of *progress* in vegetation, and in the operations of the field, none of the greater ones of which are begun or terminated, but only advanced a step towards their maturity in autumn. The advancement of the larger field operations involves no difference of principle in their execution, but the minor operations which accompany them, and the changes they effect in the aspect of the larger ones, in the most agreeable season for work in the year, invest all the operations of summer with peculiar interest, and even delight.

2960. "Summer is the bloom of the year," as Mr Mudie truly observes—"the period during which all the growing and living children of nature, which wax and wane with the revolving seasons, are in the spring-tide of their activity, and when all those general agencies by which they are stimulated are working to the very top of their bent. . . . Summer is, both in the literal and the metaphysical sense, the season of blossoms; and, as the blossoms make the fruit, the time of them is really the most important of the whole. In our middle latitudes, there is

a very beautiful instance of design and adaptation in this. The grand stimulating agent in all terrestrial action, at least in a natural view of it on the surface of the earth, and the intensity of this action, is made up of two elements—the portion of the twenty-four hours during which the sun is above the horizon, and the altitude of the sun above that horizon. Both of these, in either hemisphere, increase as the sun declines towards the hemisphere, or rather as the hemisphere inclines to the sun; though, as the first of these is the apparent result of the second as a reality, our using the one expression or the other does not affect the result. The increase or decrease of altitude is the same, with the same change of declination, in all latitudes; but the variation in time above the horizon increases with the latitude: consequently, the higher the latitude the greater the change of solar action with the same change of declination. The change in declination increases from the solstice to the equinox, and diminishes from the equinox to the solstice. Thus the increase of solar action begins to slacken at the vernal equinox in March, and gradually diminishes till it becomes 0 at midsummer; after this the decrease commences. This, however, is only in so far as depends on the altitude of the sun; for the other element, the time which the sun is above the horizon, goes on increasing till the longest day, or day of the solstice. Thus, in the

advanced part of the summer, there is a diminished increase of the momentary intensity of the solar action, and a lengthening of its daily duration. What is given to the presence of the sun above the horizon is taken from its absence below it; and thus, as the summer advances towards the longest day, all that works by the action of the sun works with his increase of intensity, and for a longer time. After the longest day is past, both elements of the solar action diminish, slowly at first, and more rapidly afterwards, until the summer merges in the autumn. Near the equator the changes are comparatively small, and they increase with the latitude; and the differences in this respect are what may be called the celestial differences of the character of summer in different latitudes; but terrestrial causes modify them so much, that the practical results, as observed, are very different from what the celestial theory would give. Still, any one who thinks but for a moment will not fail to discover how beautifully the season of bloom is secured from violent action either in the one way or the other. This is enough to convince us that the action which goes on in the production of nature during the summer is really the most important of the whole year; for it is performed with the maximum of power in the agents, and the minimum of disturbance in their operation. That resistance of winter, which but too often shrivels the young leaf, and blights the early blossom in the spring, is vanquished and completely stayed from making any inroad till the seasonal purposes of nature are accomplished; and the ardour of the stimulating causes which have vanquished the destructive one are slackened, so that they may not injure that which, during the struggle of the early part of the year, they have preserved. All this, too, is accomplished by means so very simple, that their simplicity proves the most wonderful part of the whole, for it is nothing more than the planes of the annual and daily motions of the earth intersecting each other at an angle of about $23^{\circ} 28'$; and the line of intersection passing through the equinoctial points of the diurnal orbit."

2961. The atmospherical phenomena of summer are of the most varied and complicated nature. At one time the air

is highly elastic, and feels balmy and bracing, indicated by the high position of the mercury in the barometer; at another the mercury descends, and almost always suddenly, to the lowest point, followed by blasts of wind and a deluge of rain, imitating the tornado of the tropics. The heat of the air so scorches us as to cause us to seek the shade, and the thermometer marks its intensity; and shortly after, a chilling gust, accompanied with hail, suddenly brings down the thermometer many degrees. The air to-day is so calm and breathless, that not a ripple is visible even on the broad bosom of the great ocean; to-morrow a hurricane agitates its waves to a height dangerous to the safety of the mariner. Not a cloud is seen at times to stain the purity of the blue vault of heaven; at others, the thunder-cloud hovers over the earth, and blackens its surface with a portentous shadow.

2962. Such changes, in summer, are usually sudden and of short duration, and are requisite to preserve the healthy state of the atmosphere. Did rain not fall in large quantities, the vapour absorbed by the increased capacity of heated air for moisture would accumulate in the atmosphere, and form perpetual clouds and sunless days. Did no cold strata of air move about to condense the warm, the warm, containing a large quantity of vapour in solution, would always be elevated beyond the reach of the earth, and there waste its latent heat. The sheet-lightning passing from cloud to cloud, the most common display of electric action in summer, restores the electric equilibrium of the air, and the forked lightning relieves both the earth and the air. Did not the hurricane at times force its way through the calm and settled air, the same portion of the atmosphere would always remain over the same locality, and become vitiated by the breath of animals and the exhalations from decaying vegetables. If the dews failed to descend upon the grass, the pastures would soon become parched by the meridian fervour of the summer sun. Thus, the active agencies of nature are all required to preserve the air in a healthy state for animals and vegetables, and they operate in the most beneficial manner in summer—the season of the intensest action of the solar rays.

2963. The influence of the laws of nature, which effects such changes in the atmosphere, also affects the condition of the human race; "for if the laws of nature," says Mr Mudie, "have been so framed by the Lawgiver as to place the summer of the year in the situation of greatest safety in the year's revolution, so ought the summer of the life of man to be placed in the situation of greatest safety among the stages of his appointed time on earth. Nature does this in the case of all irrational animals which belong wholly to material nature, and are, of course, in complete obedience to material laws. In so far, too, as man is under the laws of material nature, he is under their protection. But man, even considered as body or animal, is not wholly under the protection of these laws; for from the moment that the mind has acquired the requisite degree of experience which prompts him to the exercise of his young judgment, he begins to exercise it, and this takes place long before he is able to regulate himself even in what those who have had larger experience consider very simple cases. . . . This is a period at which the burden of bodily labour of every kind should be lighter than at any other period. It is usually the time of most rapid growth, and therefore the one of greatest comparative weakness in the whole system. It is the time when the body is most subject to consumption, and to various other diseases from which, if this time is fairly got over, there is comparatively little to fear in after life; and, such being the case, we may very naturally infer that it is the time when the bodily constitution is rather confirmed in strength or given over to feebleness. It is also the time at which the deepest impressions are made; because it is then that the keenness of the senses to observe, and the readiness of the mind to receive and retain the result of the observations, are most usually upon an equality. The time of perfect equality may be earlier in some cases and later in others; but we believe we have truth on our side when we say, that at some time within the limits of ten years, the perfect equipoise of the balance between the senses and the mind actually takes place.

2964. "This is in fact the summer of life to which we have already alluded;

and we cannot help admiring the delightfully benevolent design with which this period of life—the grand period of fitness and disposition to observe—and the summer of the year, the season when, beyond all others, nature is inviting to observation, and fitted to reward its exercise, are adapted to each other. But though the summer is, in especial manner, valuable and inviting at the age we have named as corresponding to it in our life upon earth, yet every human being, from the earliest dawn of observation to the final close, may find much pleasure in the summer, if they seek it aright.

2965. "Though summer is unquestionably the most delightful portion of the year—the one which, above all others, is hailed and enjoyed by every one who has senses to perceive, or a heart to feel, and a mind to understand the great goodness of the Creator in placing man in a world of so many and so sweet enjoyments—yet summer is not a season of which we can mark the beginning or the end by fixed days in the calendar, or of which we can say that it has definite characters which belong to it only, and to no other of the year. Even with us, in the comparatively mild latitude of Britain, where none of the seasons run into extremes, we cannot say that summer is absolutely the warmest time of the year; because we sometimes have a very warm day in the spring, which, probably from the contrast with the general character of the season, we feel fully more than we do many days in the summer. So also there are often days in the autumn upon which we feel the heat more oppressive than we do upon summer days; though this may in part arise from the greater length and comparative coldness of the autumnal nights.

2966. "Limited as the island of Britain is to a range of only about six hundred miles in the meridian, which is just about one-tenth of the quadrant from the equator to the pole, there are very great differences in the character and economy of the summer in different parts of it; and these are still further increased by difference of elevation above the level of the sea, and other local causes. In general, the double season of activity, and the pause during the very vigour of the warm and dry

season, are much more marked in the southern part of the island; while in the extreme north they may be said to be altogether unknown. In those remote parts there are hardly any spring flowers, and very few autumnal ones. On elevated places, the snow will retreat before nothing short of summer; and it returns, in occasional showers, even in June. Thus, summer is hardly gone when the snow returns and maintains its ground till next summer. When the duration of summer is so brief, there can, of course, be few instances of second flowering or growth in plants, or of second broods in birds. The plants analogous to the early flowerers of the southern parts are not many; and of the summer birds which make the southern groves and copses so gay with their songs, the far greater part do not reach the extreme north. There is a double reason for this. In the first place, the summer is too short; and, in the second place, there are few or no groves for them to visit; and in some of the lonely moors there, one may wander the livelong summer's day without hearing any sound of bird, save the hoarse croak of the hooded crow, or the peevish and melancholy 'twite' of the mountain linnet.

2967. "Viewing our own country, therefore, limited as it is in range of latitude, we may say that the summer is cleft in twain in the warm and dry places of the earth by the ardour of the summer drought, which comes in the maximum of that season, and has an enervating influence on vegetation; and that the two segments approach each other as we proceed northward, meeting so as to form only one summer at different distances, according as the surface is higher above the level of the sea, with an unbroken progress in vegetation maintained by the presence of an adequate supply of moisture.

2968. "But the extra heat which parches the dry plains in summer is actually a store provided for man, and provided where he cannot find anything in art to answer the same purpose. Man can neither cart the sunbeams into his fields, nor collect and retain them in reservoirs; and therefore the bounty which gives him this summer surplus is a bounty for which he ought, nay, is bound, to show his grati-

tude by turning it to proper account. Crops of grain, pulse, and of artificial grasses, especially the leguminous ones—the tall growing clovers, the lucerns, and the sainfoins, retain the humidity in a wonderful manner; and all the leguminous crop-plants, which completely cover the ground, are understood to give it more by this means than they take from it by any other, and thus to be ameliorating crops instead of scourging ones; but, in order to do this, they must completely cover the ground, so as to exclude from it all scorching action of the sun. Plantations, copses of trees, hop-gardens, and all other vegetable shadowings, while keeping the scorching heat of the sun from the ground, in the times of its extreme strength, have similar effects, only differing a little with the nature of the plants, and the varying demands which their roots may have upon the soil, for that ill-explained and understood something which they are generally supposed to derive from it. In bleak situations, a wonderful acceleration is often produced by plantations of evergreen conifers, especially of the common Scotch fir, (*Pinus sylvestris*.) which is at the same time one of the most valuable as timber. And there have been many instances of a plantation of this kind yielding a good rent during the time that it stood; and then, when it had come to the growth most proper for cutting down—the but-ends of the tree for ordinary deal timber, and the top-cuts for pit-props, used in the collieries—the surface upon which it stood had accumulated so much soil during the time of its standing, that very little expense sufficed for converting it into corn-land, capable of bearing excellent crops.

2969. "There are instances in which the vegetables that man has sown or planted, have of themselves furnished no small portion of that auxiliary power of the retention of humidity in the fields which enables the whole of that surplus of summer heat, above what the natural condition of the place requires, to be converted to useful purposes. There are other results equally striking and profitable as these. In many parts of the uplands which, not many years ago, were in the naked and unproductive state which is common to such places when they are neglected, the most advantageous results have been obtained from belts and

clumps of planting, and the bringing of the surface into culture. While they remained in a state of nature, the summers were intolerably hot and dry, and the winters were excessively cold, with heavy falls of snow, frequently coming on about the middle of January, and sometimes renewed in March—so that they lay long, and field labour could not be begun until the season was far advanced. This rendered the grounds immediately adjoining of little value for tillage, and the wastes themselves of as little for pasturage, as the people in the vicinity had no keep for cattle during the long winter, and sheep were altogether out of the question. When a few cattle were kept in such places, they were in a sad condition in the spring, from the scanty supply and bad quality of their winter food, which consisted almost wholly of straw, unripened, black, sodden, and sapless, from the effect of the autumnal rains. In consequence of this, when the cattle were put out to the upland, after the sun had brought up the grass, a man had to be sent along with them, to lift them in the case of their lying down and falling, as they had not strength to regain their legs by their own exertions. The change of food had also very unwholesome effects upon them, and many used every year to die of murrain, a disease which was understood to be infectious—so that, if it once broke out, it was difficult to say to what length it might not proceed. The country people went so far as to say that crows and ravens, which are certainly not very delicate birds, were sometimes poisoned by the carrion of cattle that died of this malady; and when they found these dusky-coated prowlers on the moors hanging about the outskirts of the herd, they always concluded that these birds ‘smelt death’ among the cattle.

2970. “What has been stated was not the whole of the evil. The short summer came on so very hot that the dry pastures were burnt up; the little patches of cultivated ground in the neighbourhood were hardened like bricks; and the crops late sown, from the length of time the snow lay, could not rise with any vigour in the main stem, or at all ‘tiller’ at the roots, so that they never so covered the ground as to shut out the searching influence of the spring. Thus, as the summer advanced,

there was an approximation to the character of the season of burning drought, as it shows itself in the seasonal desolation of tropical plains; and as there was no power in the average temperature of the year to produce the bulbous and tuberous plants, which so speedily bring beauty upon those plains when the rains do set in, the general character of the whole was sterility.

2971. “It is not probable that at any time the seasons, in the most neglected parts of Britain, ran into such extremes as this; but still they were very different from what they are now, and had far more pernicious effects in injuring the health of man, and reducing the produce of the fields to a very small fraction of that which, by proper management, they now regularly afford.

2972. “This may seem to be treating of the desolation of winter rather than the bloom and beauty of the summer, and it is not a subject of bloom or beauty certainly; but still it is a summer subject, and one the knowledge of which is far more useful than any descent that could be written on the most lovely feature of the most delightful and propitious season. The real cause was the improper management of the summers—in the suffering of that part of it which God has obviously provided for man, as that element of successful cultivation which he cannot obtain by his own exertions, to run to waste; and thereby allowing that which has evidently been created for being the blessing of art, to become the bane of nature.

2973. “It is pleasant to view the contrast produced, when this surplus of summer energy is seen and appreciated, and so made to perform useful work in its own season; and though at that season the effect is delightful, and greatly heightens the charm of the summer, it is not confined to that season, but extends to the whole year, rendering every season more healthy and productive, and greatly adding to the enjoyment of life.

2974. “When the excessive ardour of the summer is thus turned to good account, in the promoting of growth, and cooled by evaporation constantly going on from fields

of corn coming into bloom : when the bean and the red clover give the full volume of their combined perfumes to the lightest zephyr that flits from field to footpath ; and when the fields are cultivated up to the power of the season, the little zephyrs do sport at these short journeys as if they were specially commissioned to sweeten your path as you walk along ; when the hay-field, ready for the scythe, plays in gentle undulations, as if it were a sea of beryl ; when the rich pastures, starred over with the sweet though lowly blossoms of the white clover, breathe balm and honey combined, and the industrious bees are flitting from flower to flower, softening the air with their mingled hum of delight ; when the fresh breeze from the copse faces you as you pass, and the trembling poplar by the brook salutes you with all its leaves ; when the birds, many of them from transequatorial climates, are enjoying their meridian siesta, in order that they may pour forth their gratitude in vesper or in matin song ; and when man, and all that belongs to him, living or dead, speaks of plenty, and comfort, and high health, and full of grateful enjoyment—then, then it is summer, such as becomes rational man in a land highly privileged by a bountiful God : and you require no verbal definition.*

2975. The atmospherical phenomena of summer are not only varied, but are of a very complicated character, difficult of explanation, and apparently anomalous in occurrence. These are *dew*, which is a great deposition of water at a time when not a cloud is to be seen ; a *thunder storm*, which suddenly rages in the midst of a calm ; and *hail*, which is the descent of ice and congealed snow in the hottest days of the year. Each of these anomalous phenomena requires explanation.

2976. *Dew*.—The phenomenon of dew is familiar to every one residing in the country. In the hottest day of summer, the shoes become wetted on walking over a grass-field about sunset, and they may be wetted as thoroughly as in wading through water. The late Dr Wells investigated the phenomena of dew more closely than any other person. His experiments, as detailed in his instructive essay on

that subject, appear to have been very satisfactorily conducted, and the theory which he established by these experiments is the one now embraced by all philosophers. “ Aristotle and many other writers,” says Dr Wells, “ have remarked, that dew appears only in calm and serene nights. This remark of Aristotle, however, is not to be received in its strictest sense, as I have frequently found a small quantity of dew on grass, both in windy nights, if the sky was clear or nearly so, and in cloudy nights if there was no wind. If, indeed, the clouds were high and the weather calm, I have sometimes seen on grass, though the sky was entirely hidden, no very inconsiderable quantity of dew. Again, according to my observation, entire stillness of the atmosphere is so far from being necessary for the formation of this fluid, that its quantity has seemed to me to be increased by a very gentle motion of the air. Dew, however, has never been seen by me on nights both cloudy and windy. If, in the course of the night, the weather, from being calm and serene, should become windy and cloudy, not only will dew cease to form, but that which was formed will either disappear or diminish considerably. In calm weather, if the sky be partially covered with clouds, more dew will appear than if it were entirely covered, but less than if it were entirely clear. Dew probably begins in the country to appear upon grass, in places shaded from the sun during calm and clear weather, soon after the heat of the atmosphere has declined ; and I have frequently felt grass moist in dry weather several hours before sunset. On the other hand, I have scarcely ever known dew to be present in such quantity upon grass as to exhibit visible drops before the sun was very near the horizon, or to be very copious till some time after sunset. It also continues to form in shaded places after sunrise ; and if the weather be favourable, more dew forms a little before, and in shaded places, a little after sunrise, than at any other time. The formation of dew, after it has once commenced, continues during the whole night, if the weather remain still and serene. During nights that are equally clear and calm, dew often appears in very unequal quantities, even

* Mudie's *Summer*, p. 1-64.

after allowance has been made for any difference in their lengths. One great source of their difference is very obvious; for, it being manifest, whatever theory be adopted concerning the immediate cause of dew, that the more replete the atmosphere is with moisture, previously to the operation of that cause, the more copious will be the precipitation of moisture in the atmosphere, which must likewise tend to increase the production of dew. Thus dew, in equally calm and clear nights, is more abundant shortly after rain than during a long tract of dry weather. It is more abundant during S. and W. winds, than during those which blow from the N. and the E. Dew is commonly more plentiful in spring and autumn than in summer; the reason is, that a greater difference is generally found between the temperature of the day and the night in the former seasons of the year than in the latter. Dew is always very copious on those clear and calm nights which are followed by misty or foggy mornings; the turbidness of the air in the morning showing that it must have contained, during the preceding night, a considerable quantity of moisture. I have observed dew to be unusually plentiful on a clear morning, which had succeeded a cloudy night. For the air having, in the course of the night, lost little or no moisture, was in the morning charged with more watery vapour than it would have been if the night had also been clear. Heat of the atmosphere, if other circumstances are favourable,—which, according to my experience, they seldom are in this country,—occasions a great formation of dew. For, as the power of the air to retain watery vapour in a pellucid state, increases considerably faster while its temperature is rising than in proportion to the heat acquired, a decrease of its heat in any small given quantity during the night must bring it, if the temperature be high, much nearer to the point of repletion before it be acted upon by the immediate cause of dew, than if the temperature were low. I always found, when the clearness and stillness of the atmosphere were the same, that more dew was found between midnight and sunrise than between sunset and midnight, though the positive quantity of moisture in the air must have been less in the

former than in the latter time, in consequence of a previous precipitation of part of it. The reason, no doubt, is the cold of the atmosphere being greater in the latter than in the prior part of the night.*

2977. *Theories* of the formation of dew have been proffered by many philosophers, from the days of Aristotle to the time of Dr Wells; and these have been referred to in (176,) as also the observations of Dufay on the perspiration of moisture from the earth, (177.)

2978. To measure the quantity of dew deposited each night, an instrument is used called a *Drosometer*. The most simple process consists in exposing to the open air bodies whose exact weight is known, and then weighing them afresh after they are covered with dew. According to Dr Wells, locks of wool divided into spherical masses of $3\frac{1}{2}$ inches diameter, are to be preferred to any other thing for measuring the deposit of dew. All circumstances that favour radiation equally contribute to the formation of dew. A body that is a good radiator and a bad conductor of heat, will therefore be covered with a very abundant dew. Thus glass becomes wet sooner than the metals; organised bodies are wetted more quickly than glass, especially when they are in small fragments—because, as the heat passes with difficulty from the one to the other, that which is lost is not replaced by that which is transmitted from the interior to the surface of the body. Thus locks of wool are very well suited to these experiments, and become covered with a very abundant dew. The moister the air is, all other things being equal, the more considerable is the quantity of dew that falls in a given time. Thus, it is entirely wanting in arid deserts, notwithstanding the intensity of nocturnal radiation. In our country, nights with abundant dews may be considered as foretelling rain; for they prove that the air contains a great quantity of the vapour of water, and that it is near the point of saturation. Dalton computed the amount of dew which annually falls at 5 inches. In fine weather, in the evening, the vapour plane being destroyed, and the nubific principle, as Mr Forster observes, ceasing to act, the

* Wells *On Dew*, p. 1. 1815.

vapour so deposited comes down in dew. Dew, however, is not the result always of the stratus cloud, and it differs from the wet mist of the cirro-stratus of the lower atmosphere.

2979. As supposed depositions from the air, which take place usually in summer, and accompanied chiefly with rain, are the showers of remarkable substances, such as sulphur, blood, corn, fishes, and others, which have been said to have occurred in several places, and which I mention more as matters of curiosity than of importance, with the view of correcting the popular ideas entertained of them. *Showers of Sulphur*.—Formerly, and even at the present day, flour of sulphur has been said frequently to fall with rain; after heavy showers, quiet waters have been found covered with a yellow dust, which, being easily inflamed, was believed to be sulphur. Accurate researches have proved that the dust was nothing else than the pollen of certain flowers, and of pines in particular, which had been swept off by the wind and precipitated by the rain. The nature of the pollen depends on that of the vegetables that grow within a certain distance. Schneider believes that, in March and April, it is the pollen of alders and filberts; in May and June, that of pines, elders, birch; in July, August, and September, that of lycopodium, typha, and several species of equisetum. *Showers of Blood*.—Red spots have been found on the ground and on the waters, which were believed to be spots of blood. Microscopic researches have proved that those colourings arose from innumerable vegetables or animals, some filling the waters, and others—inorganic substances in the form of powder—falling on the ground, were found coloured with iron or hydrochlorate of cobalt. *Showers of Corn*.—After heavy rains, bodies have frequently been found on the ground that possessed a distinct analogy to grains of corn, and appeared to be composed of farina; but were found not to be the grain of the cereals, nor had they fallen from the air. In June 1830 were found near Greisau, a village of Silesia, after a rain storm, a certain number of small bodies of a vegetable nature, on places covered with turf. They had the taste of farina, but

left in the mouth a sharp and burning after-taste. On examination, these grains were found to be the tubercles of the ficaria, *Ranunculus ficaria*, a plant very common in Silesia. In the middle of June the leaves and stalks of this plant dry up, and the tubercles having but loose hold of the ground, the wind sweeps them off their sites, and the rains then carry them to a distance, but no one has seen them fall from the clouds. The seeds of the *Melampyrum nemorosum*, of the *Veronica hederifolia*, and of others, have been known to be thus transported by wind and rain to considerable distances from their habitats.

2980. *Showers of Animals*.—One has frequently heard of the fall of fishes and frogs from the air; and the common idea is that they had been taken up by water-spouts into the clouds, and thence let fall upon the earth with the rain; and it has even been asserted that they have fallen from the sky in calm weather. "To all these assertions," remarks M. Kaemtz, "I know no other answer than that which one of the most distinguished naturalists of the age made to one who assured him that he had seen such a phenomenon with his own eyes: 'It is fortunate,' he said, 'that you have seen it, for now I believe it: had I seen it myself, I should not have believed it.'"

2981. *Dry Fogs*.—From 29th May to 1st July 1783 a dense dry fog was seen over the greater part of Europe. The fog was not an aqueous vapour, but a true smoke. Veltmann ascertained that simultaneous with it great peat-bogs were burning in Germany that dry summer, as also were great volcanic eruptions in Calabria and Iceland, the hot lava from which burned much vegetation and many dwellings. In the dry summer of 1839 a similar dry fog was occasioned by burning bogs.*

2982. *Summer Electricity*.—The nature and sources of electricity have already been fully explained from (123) to (130.) As summer is the season in which electricity is most active in displaying its existence, a few remarks on its condition in this season seems appropriate. Its usual state in the atmosphere is generally be-

* Kaemtz, *Complete Course of Meteorology*, p. 106, 465.

lieved to be positive, and that it increases in quantity as we ascend. In Europe, the observations of M. Schübler of Stutgardt intimate that the electricity of the precipitating fluids from the atmosphere is more frequently negative than positive, in the proportion of 155 to 100; but that the mean *intensity* of the positive electricity is greater than that of the negative in the ratio of 69 to 43; and that different layers or strata of the atmosphere, placed only at small distances from each other, are frequently found to be in different states.* It appears also, from recent observations by Schübler, that the electricity of the air, in calm and serene weather, is constantly positive, but subject to two daily fluctuations. It is at its minimum a little before sunrise: after which it gradually accumulates till it reaches its first maximum at 8 A.M. in May; and then diminishes until it has descended to its second minimum. The second maximum occurs in the evening about two hours after sunset; and then diminishes at first rapidly, and next in slower progression during the whole of the night, to present again, on the following day, the same oscillations. It is probable that the exact time of its increase and decrease is influenced by the seasons. The intensity increases from July to January, and then decreases; it is also much more intense in the winter, though longer in summer, and appears to increase as the cold increases.† These fluctuations may be observed throughout the year more easily in fine than in cloudy weather.

2983. "Among the causes modifying the electric state of the atmosphere," observes Dr Bird, "must be ranked its hygrometric state, as well as probably the nature of the effluvia which may become volatilised in any given locality. Thus, Saussure has observed, that its intensity is much more considerable in elevated and isolated places than in narrow and confined situations: it is nearly absent in houses, under lofty trees, in narrow courts and alleys, and in enclosed places. In warm places, the most intensely electric state of the atmosphere appears to be that in which large clouds and dense fogs are suspended in the air, at short distances

above the surface of the earth: these appear to act as conductors of the electricity from the upper regions. Cavallo ascertained, from a set of experiments performed at Islington in 1776, that the air always contains free *positive* electricity, except when influenced by heavy clouds near the zenith. This electricity is found strongest in fogs, and during frosty weather, but weakest in hot weather, and just previous to a shower of rain; and to increase in proportion as the instrument used is raised to a greater elevation. This, indeed, necessarily happens; for as the earth's surface is, *ceteris paribus*, always negatively electrified, a continual but gradual combination of its electricity with that of the air is constantly taking place at its surface, so that no free positive electricity can be detected within four feet of the surface of the earth." ‡

2984. *Thunder-storm*.—Although the presence of electricity is thus accounted for, its manifest action in a thunder-storm is not easily analysed. Storm-clouds are at first small, and they rapidly become larger by accumulating all the vapours around them, when the sky is generally seen of a pale-blue colour. At times storm-clouds are formed in the horizon, where they remain either isolated or unite together. Their characteristics are, that the cirri found in the upper part of the atmosphere pass to a state of thick cirro-cumulus, through the cumulus, to a compact and uniform mass of cumulo-stratus. The entire mass presents remarkable opposition of light—one part being densely blue-black, others ash-gray—and if the sun is near to setting, a yellow or orange colour may pervade the entire mass.

2985. The formation of storm-clouds is preceded by a slow and continued fall of the barometer, as must be the case when cirri occupy the sky. The calmness of the air, and a suffocating heat, due to the want of evaporation on the surface of our bodies, are circumstances quite characteristic. The heat does not proportionately affect the thermometer, and is peculiar to the lower strata of the air, for it decreases

* Forbes's *Report on Meteorology*, vol. i. p. 253.

† *Journal of Science and of the Arts*, No. IV.

‡ Bird's *Elements of Natural Philosophy*, p. 209.

rapidly with the height—twice as rapidly as in ordinary circumstances.

2986. The electric fluid accumulates in the clouds of vapour. When two clouds, thus provided with electric matter beyond their usual state, are not far from each other, the electricity of the one always becomes *positive*, and that of the other *negative*. Being in the opposite states of electricity, they attract and approach each other; and when the approach comes within the distance in which the force of the positive electricity is able to overcome the resistance of the air between the positive and negative clouds, the fluid leaves the positive and enters into the negative cloud in lightning in such quantity as to restore the equilibrium of both. The forcible passage of the fluid causes such a concussion in the air between the two clouds that its vibrations, striking against the earth and mountains, cause the noise which is heard in thunder.

2987. The time taken by the electric fluid to pass from one cloud to another is inappreciable, but the velocity of sound is calculable. For every $4\frac{1}{2}$ seconds of time which elapse after seeing the lightning to hearing the thunder, the clouds are situate as many miles from the auditor. Far at sea, where are no objects for sound to be reflected from, thunder is very seldom heard: whereas in a mountainous country it inspires terror, though, being mere sound, it can do no harm; while the lightning, which can do harm, does all the mischief it can before we are aware of its presence.

2988. Lightning is of three kinds. If the lightning joins two clouds, whose height is not equal, the sky appears irregularly illuminated. If the lightning goes from a cloud to the earth, we observe a narrow train of dazzling light, surrounded by a less intense light. We observe the same train when it joins two clouds of equal height, because there is no lower cloud in this case to hide it from our view. The two sorts of lightning are of course identical, and we name them differently because they affect our sense of sight differently. When we remark a point of light which is not clearly defined, we call it *sheet* lightning. When lightning is of

a zigzag form, though in reality it is of the form of a helix, or spiral screw, we call it *forked*. The unequal conductivity of the air explains this course of lightning, as well as its bifurcations. The third kind, *ball* lightning, passes slowly from the clouds to the earth, and is visible for several seconds; whereas the lightnings of the other two kinds do not last for the millionth part of a second, according to the observations of M. Arago.

2989. Lightning is generally of a dazzling white colour, and when the electric spark is sent through *vacuo*, it is always of a blue colour, which would seem to indicate that the true colour of electricity is blue. Now, as electricity is known to promote vegetation, (135 to 150.) and as the blue rays more greatly accelerate vegetation than any of the others, (193,) the exciting action of electricity in plants may be connected with its blue colour.

2990. The motion of the electric fluid is most commonly from the clouds to the earth, though numerous examples exist of its having followed an opposite direction. It is probable, however, that in most cases of electric explosion, the fluid leaves both clouds, or the cloud and the earth, at one time. However this may be, the stroke always goes in the most direct line, even through substances of the least conducting power. Animals are frequently struck, because their fluids easily conduct the fluid; while the shock given to the body seems to be through the nervous system.

2991. Hence lightning-conductors, called *paratonnères*, have been recommended not only to draw off the fluid quietly from the atmosphere into the earth, which they certainly do when attached to houses, but also with the view of lessening the number and virulency of thunder-storms, which it is doubtful that any number of conductors would effect—since at Zurich, and its vicinity, the houses are studded with conductors, and storms are not less rare there than elsewhere.

2992. Electricity emits a peculiar *odour*, something like sulphur, or perhaps rather garlic. This odour is generally attributed to the discharge of minute par-

ticles of metal from the conductor of the electric machine; but Professor Schoenbein of Basle considers it to arise from an elementary body, which he calls *ozone*, liberated from combination by the decomposing action of electricity, and which, in its electrical characters, resembles chlorine, bromine, and iodine; and it has been stated that he has actually decomposed nitrogen into hydrogen and ozone.

2993. The noise of thunder is not always the same, for when it falls direct to the surface of the ground, those near hear a dry noise of varying power, which ceases immediately; while those at a distance hear a series of noises rapidly succeeding each other, completely different however from the volleys of thunder. M. Dove explains these varied noises thus:—With a flash that falls directly, the noise caused by the first explosion is heard at the same instant as the last; while in a horizontal flash, the noises produced at the greater distances arrive later than the others, and a flash which extends over 2000 yards will produce a noise which will last 7 seconds. In the zigzag lightning the noise reaches the ear at different intervals; and it is at the angles that the noise is strongest, on account of the compression of the air, and hence the unequal intensity of the sound. The rolling of thunder is thus explained by M. Arago: “Lightnings only occupy a point in space, and give place to a short and instantaneous noise. Multiple lightnings, on the contrary, are accompanied by a rolling, because the different parts of long lines which the lightnings occupy are in general found at different distances, and the sounds which are there engendered, either successively or at the same physical instant, must employ times gradually unequal in order to reach the ear of the observer.”

2994. All thunder-storms may be divided into two classes, the one class being due to the action of an ascending current, and which only occurs in the hot season; and the other class is the result of a conflict between two opposite winds, and is the cause of the winter thunder-storms.

2995. Thunder-storms in summer always commence with cirri, and when these become thicker, or when several

strata of cumuli exist beneath, the clouds make a vertical exchange of lightnings. We must therefore assign to storms a great height, in contradiction to the generally received opinion, and no storms have been measured at a lower position than 4000 feet from the earth to the lowest part of the lowest clouds.

2996. On a serene evening, in summer, we often see after sunset intermittent lights that illumine a great portion of the sky, and these are called *heat lightnings*.

2997. When a storm is situated below the horizon, we observe in the evening, and during the night, very brilliant flashes of lightning—while no thunder is heard, because the storm is too far distant from the observer for the noise of the thunder to reach his ear. Every one may convince himself that lightnings are reflected through the air with great intensity on a dark night. When a storm is in the W., and the remainder of the sky is serene, we have only to turn our back to the storm to see the lightning reflected in the E.

2998. In a thunder-storm, says M^r Tessau, “flashes of lightning, of a terrible brilliancy, succeed each other with extreme rapidity, and are almost instantly followed by tremendous claps of thunder, which are themselves succeeded by deluging showers.” But though the order of the phenomena is obvious, and well understood, yet the ruling cause of the order is a matter of dispute—it being yet unsettled whether the *storm produces the electricity or the electricity the storm*. M. Tessau, following the order of phenomena, supports the latter view; and Kaemtz supports the former with this reasoning:—“A flash of lightning passes the zenith, and before the clap of thunder, but rarely afterwards, the rain or hail escapes in torrents from the cloud; the drops at first in a line inclined to the horizon, and then return to a vertical direction. It is commonly stated,” he observes, “that the rain is the effect of the lightnings tearing the clouds; but it is the gust of wind condensing the vapours into large drops, having first driven them into a horizontal direction: hence, the escape of electricity, and the clap of thunder. As a proof that this condensa-

tion precedes the lightning, the rain often falls before the noise of the thunder is heard. Now, the latter travels 333 metres (1092 feet) per second; if, therefore, the rain was an effect of lightning, it would follow that the drops of water would have fallen with a velocity at least equal—a velocity which they never have, even at the end of their fall.*

2999. Thunder-storms are of great use in the economy of the atmosphere. The surplus electricity is disposed of to the earth, the surplus vapour is condensed and sent down to the earth in rain, the air is prevented from becoming stagnant, the extraneous matters floating in the air are brought down to the earth, whether these be in a solid or gaseous state, (290 to 295.)

3000. *Hail*.—The fall of ice from the atmosphere in the hottest weather is a phenomenon not easily solved. That both snow and ice are required in the formation of hail there cannot be a doubt. "The form of hailstones varies. They are nearly uniform when they fall on the same level; and in the same storm they have fallen smaller on the tops of mountains than on the plains. Change of temperature or wind alters the form of hail. On 7th July 1769, M. Adanson observed six-sided pyramids fall; but the wind changing to N.E., changed them to convex lenses, and so transparent as to transfer objects without distortion. Hail is sometimes attended with spongy snow, which may have formed the interior of the hailstone, while its exterior was transparent ice. It has been supposed from this, that the different portions have been formed under different circumstances. Leslie imagines the spongy texture to result from an atom of water having been suddenly frozen, and particles of perhaps rarified air suddenly driven into the centre. The pyramidal form fell at Aberdeen on 29th November 1823. The usual form of hail is a concentric lamellar structure, with a stellular fibrous arrangement."†

3001. Hail generally falls in the hottest hours of the day in Spain, Italy, and France. It falls in Europe generally in

the day, and seldom in the night. In England hail falls most in winter; and at Plymouth, according to Mr Giddy, in the course of 21 years, its recurrence in each month was, in

	Times.		Times.
January,	23	July,	1
February,	25	August,	0
March,	25	September,	5
April,	27	October,	17
May,	7	November,	22
June,	5	December,	43

In August is absolute zero, and in December is the maximum. The appearance of hail-clouds seems to be distinguished from other stormy clouds by a remarkable shading; their edges present a multitude of indentations, and their surfaces disclose here and there immense irregular protuberances. Hail seldom falls in deep valleys surrounded by mountains. It falls more on the sea-coast than in the interior of a country.

3002. Noise frequently accompanies or precedes a fall of hail. It is probably due to the hailstones beating against each other, or to the conflict of contrary winds. The latter are frequently so violent that the hailstones are transported in a horizontal direction. It is often observed that the wind blows in puffs, and that each of them is accompanied with a torrent of hail. If the hail falls as usual at intervals, hailstones, which are at first driven horizontally, finally mingle with the drops of rain; and in the end there is nothing but rain, the drops falling vertically on the surface of the earth.

3003. Although hail-storms are very violent, they occupy but a very limited space. They will occur at the foot of mountains and in the plain, while nothing but rain falls on the mountains adjoining, and in their march they leave a narrow train of hailstones.

3004. Both the barometer and thermometer are affected by hail-storms. The barometer falls on the approach of a hail-storm, and immediately after the storm has passed the temperature falls, and the contrast is the more severely felt in consequence of the great heat prior to the approach of the storm. The lowering of the

* Kaemtz' *Complete Course of Meteorology*, p. 345-368.

† *Encyclopædia Metropolitana*—art. *Meteorology*, p. 129.

temperature for two or three weeks after a severe hail-storm, would indicate that such a storm has a much greater effect upon the atmosphere, and must therefore be much more extensive, than the space covered by the fall of hailstones would lead us to believe.

3005. As to the formation of hail, the difficulty of accounting for the retention of the masses of ice in the free atmosphere, as observed by Professor Forbes, is certainly very great. Volta's theory, than which none is more satisfactory, and certainly none more ingenious, is thus particularly explained by Kaemtz:—Evaporation is favoured by the solar rays striking the upper part of the cloud; the air above is very dry; the electric state of the clouds favours evaporation. Of two clouds, the one upper the other lower, the upper is first formed; the upper becomes in a state of positive, and the lower, in consequence, in that of negative electricity; the snow-flakes of the lower stratum of clouds are in the same electrical condition with it; they are therefore repelled and attracted by the upper stratum; as soon as they touch it they partake of its electricity, are repelled, and fall to the lower cloud, into which they penetrate; they are again repelled, and so on. These attractions and repulsions may last for several hours, during which time the grains unite in masses, and condense around them the surrounding vapours, which they convert into ice; they strike against each other, and originate the noise which is heard; when the hailstones have attained a certain size, the lower cloud can no longer retain them, and resisting the action of gravity, they traverse the stratum and fall to the earth. The violence of the storm is accounted for by the meeting of two opposite winds, the N. and the S. The hail is precipitated at the moment of contact. The N. wind prevails, and accounts both for the cold which succeeds and the rapid formation of hail.

3006. Pieces of straw, and in Iceland volcanic ashes, have been found within hailstones.

3007. *Paragrêles*—tall posts erected for drawing off the electricity, and opposing

the formation of hail—have been erected in parts of the Continent, to save the vineyards from the hail; and if electricity is connected with the formation of hail, these should have some such effect, but there are no authentic records of their utility. Indeed, Kaemtz asks, are not forests a collection of living paragrêles, and yet they are not spared by hail. Vegetable points possess great powers of conduction. According to Mr Pine of Maidstone, a blade of grass is a better conductor of electricity than a steel needle, and that the spines upon thorns, gooseberry bushes, and indeed the whole creation of buds and leaves, have the property of silently drawing off and conducting away electricity.

3008. *Sleet*.—Very small hailstones are termed sleet. They are mostly spherical. Isolated ones are opaque, frequently soft, and of a whiteness approaching to that of snow. The largest are sometimes surrounded with a slight film of ice. They fall in winter and spring during gusty weather, and rarely accompany storms, but always fall during gales, and when the weather is variable, and such gusts of cold wind seem a necessary condition for the formation of sleet.*

3009. *Clouds*.—The forms of the *clouds* in summer are very distinctly marked. When a deposition of vapour is taking place in the highest part of the atmosphere, the *cirrus* appears (242;) and when it soon disappears, it is a sign of fine weather; but instead of disappearing, it may descend a little lower, and be converted into the *cirro-cumulus* (250,)—an elegant, light, flocculent cloud so often seen in a fine summer day. A farther deposition changes this small cloud into the larger *cumulus*, called the day-cloud in summer, because it disappears in another form in the evening, (245.) The *cumulus* is distinctly represented in Plate XIII. of the Leicester tup near the horizon, where it frequently takes up its position for the greater part of the day, resting on the vapour plane. When a large *cumulus* rises from the horizon in the daytime, with white towering heads, it is a sign of a storm or fall of rain from that quarter; and the wind will change to that direction in the course of the next twenty-

* Kaemtz' *Complete Course of Meteorology*, p. 387 and 582.

four hours. This threatening cloud, called *cumulo-stratus*, is given in Plate VIII., of the Draught Mare. In calm serene evenings in summer, the day-cloud descends and subsides in the bottom of valleys, or spreads itself in hollows of the open country, covering the ground like a lake or a sheet of snow, as seen in moonlight, when it becomes the true *stratus* cloud. Tall objects, such as trees, steeples, and even elevated ground, jut through this cloud like rocks and islands in a lake. The air is then perfectly calm, the temperature delightfully warm, and the intensesness of the silence is broken only by the snipe drumming in its curious somersaults in the air—by the harsh ventriquoous cry of the corn-craik amongst the grass—or by the occasional barking of the watch-dog at some distant homestead. The morning after such a night is sure to usher in the sun in bright and peerless splendour, whose steady heat soon evaporates the sheet-like *stratus* cloud from the valley and hollows, elevating it, in the form of the beautiful, compact, day-cloud, above the mountain-top or vapour-plane.

3010. The effect of larger masses of cloud, and especially cumuli, on the smaller clouds in their vicinity is evidently marked in summer. The approximation of clouds towards each other is always attended with some alteration of their appearance, and clouds are constantly operating on and altering each other's forms. Analogy leads us to refer all such changes to the operation of the different states of electricity in the clouds nearest each other.

3011. *Rain.*—The character of the rain in summer is refreshing; for even in a rainy season, though we may feel displeased at being kept by it within doors on a summer day, we feel assured that it will in a great measure be absorbed by the immense mass of vegetation which is in constant activity during this season.

3012. Since the experiments of Dr Hales proved that a sunflower plant, $3\frac{1}{2}$ feet high, and an ordinary-sized cabbage, on the average perspire 22 ounces of water every twenty-four hours, and consequently absorb at least that quantity,* we

may judge of the immense mass of water required daily to supply the wants of vegetation. And when we know that evaporation, besides, carries an incredible quantity of vapour direct from the surface of the ground into the atmosphere, it may more excite our surprise where all the requisite moisture can be derived from, than that too much has been provided.

3013. The quantity of rain which falls in the summer months, as we have adopted them, taking the mean quantity as 1, is, according to M. Flaugergues, in—

May,	0·0847
June,	0·0765
July,	0·0544
	<hr/>
	0·2156.
	<hr/>

3014. The number of rainy days in the same months, according to the same authority, is as follows:—

	Days.
In May,	15·8
June,	11·8
July,	16·1
	<hr/>
	43·7
	<hr/>

3015. Of these quantities much the largest proportion of rain in the same time is derived from thunder-storms, though of course an entire rainy day may supply more than any storm. When rain falls in a shower to the extent of 1·18 inch in a day, the low plains of Europe become inundated, while at Joyeuse 8·84 inches have been known to fall in that time. In mountainous countries such showers are not rare, because the winds frequently blow with violence in several contrary directions.

3016. It is stated by Kaentz that, if on the N. of the Alps and the Pyrenees the wind always blew from the N.E., no rain would ever fall in Central Europe, and that if it always blew from the S.W. it would never be fair.

3017. The boundary-line of the province of summer rains in Europe proceeds W. from the Carpathian mountains to the N. of the Alps, through the middle of France, the west of Holland, and by the north part of the Gulf of Bothnia, through

the White Sea to the Arctic Ocean,* and it includes all that large portion of Europe to the E. of it.

3018. Every one may have observed rain to fall without the appearance of a cloud. When the equilibrium of the higher regions is violently disturbed, especially when any cold N. winds come into collision with those from the S., it may happen that rain falls from a serene sky. Large drops are seen to moisten the earth, and yet at the zenith the sky is blue. The vapours condense into water, without passing through the intermediate state of vesicular vapours. Humboldt gives several examples of the kind, and Kaemtz remarks from his own observations that the fact is not very rare, having observed it twice or thrice annually. I have frequently observed this phenomenon.

3019. *Winds*.—The character of the winds in summer in this country is gentle and refreshing.

3020. This is the season for the land and sea breezes. In fine weather, on the sea-coasts, no movement is perceived in the air until eight or nine o'clock in the morning, when a breeze from the sea gradually rises, and increases in strength to three o'clock in the afternoon, when it decreases, and gives place, after a short period of calm, to a breeze from the land towards the sea, which rises soon after sunset, and attains its maximum of velocity and extent at the moment of sunrise.

3021. The direction of these two breezes is perpendicular to the coast line, but if another breeze arises at the same time they are modified in various ways. On the E. coast of this island, if the wind blows from the E. the sea breeze will be strong, and the land breeze weak; and on the W. coast, the land breeze will be stronger than the sea breeze. These effects will be the contrary with a W. wind. In a wind from the N. or the S. both the land and sea breeze will be changed in their direction respectively to the N.E. and S.W. The sea breeze is very weak in gulfs, and the land breeze is as weak on promontories.

3022. A day wind betwixt the mountains and plains exists in the same manner as the land and sea breezes, though to a less degree.

3023. The alternation of all these winds is explained by the unequal heating of the land and of the sea, and of that of the mountains and the plain; and as continents are hotter in summer and colder in winter than the contiguous sea, the sea breeze ought to predominate in summer, and the land breeze in winter.

3024. In summer, when the wind is variable, rain is indicated, and also when the wind blows along the surface of the ground and raises the dust towards the face. When currents of air are seen to move in different directions, the upper one will most probably ultimately prevail. When it is uncertain whether there be any breeze, the lifting up of a wetted finger will instantly feel the current, and indicate the quarter from whence it comes.

3025. In summer, especially in July, the wind blows chiefly from the W.—the predominance of W. winds over E. at this season attaining its maximum; and at the same time the N. winds become more common; whence it follows that the mean direction of the wind in this season is N. of the annual mean.

3026. When the wind blows strongly from any quarter, even from the S. W., which is the warmest wind in summer, for two or three days in succession, the temperature of the air is diminished, sometimes as much as 20°, and seldom less than 10°.

3027. When small whirlwinds are seen raising the dust upon the roads or fields, it is a sign of dry weather. I remember seeing, in the neighbourhood of Berlin, a large and beautiful whirlwind, in a hot calm day, raise the sandy soil of a field, in a perpendicular direction, to a great height in the air, and move majestically away out of sight.

3028. *Evaporation*.—In proportion as the sun rises above the horizon the evaporation increases, and the air receives

* Johnston's *Physical Atlas—Meteorology*, Map iv.

every moment a greater quantity of vapour. The fact of the rising of the vapour from the ground, may be distinctly observed in summer, by the flickering with which distant objects are seen through the vapour. But as the air opposes an obstacle to the formation of vapour (229.) it becomes further and further removed from the point of saturation, and the relative humidity becomes more and more feeble. The rate continues without interruption, until the moment when the temperature attains its maximum. In summer the absolute quantity of vapour increases in the morning, but before mid-day the maximum occurs, and in different months it occurs sooner or later. The absolute quantity of vapour then diminishes, until the time of the highest temperature of the day, without however attaining a minimum so low as that of the morning. As the temperature rises during all this space of time, it follows, that the air is farther and farther from the point of saturation: after having attained its minimum, the quantity of vapour again increases very regularly until next morning, while the air becomes relatively more and more moist.

3029. Vapour being the result of the action of heat on water, it is evident that its quantity must vary in different seasons. The relative differences in the tension of the vapours of water in the spring and summer seasons, are as follows:—

In February, it is	. . .	4.749
March, ...	. . .	5.107
April, ...	. . .	6.247
Their sum,	. . .	<u>16.103</u>
In May, it is	. . .	7.836
June, ...	. . .	10.843
July, ...	. . .	11.626
Their sum,	. . .	<u>30.305</u>

The quantity of vapour attains its *maximum* in July, the month in which the air is driest. We thus see that evaporation is nearly twice as active in summer as in spring.*

3030. *Light*.—Light is a most impor-

tant element in nature, for the promotion of vegetation in summer. We have already considered its nature and composition, (from 189 to 194.) Its properties are most evidently manifested in this season, and these have been shortly and forcibly enumerated by Dr Lindley. "It is to the action of leaves," he observes—"to the decomposition of their carbonic acid and of their water; to the separation of the aqueous particles of the sap from the solid parts that were dissolved in it; to the deposition thus effected of various earthy and other substances, either introduced into plants, as silex and metallic salts, or formed there, as vegetable alkalis; to the extrication of nitrogen, and probably to other causes as yet unknown—that the formation of the peculiar secretions of plants, of whatever kind, is owing. And this is brought about principally, if not exclusively, by the agency of *light*. Their green colour becomes intense, in proportion to their exposure to light within certain limits, and feeble, in proportion to their removal from it; till, in total and continued darkness, they are entirely destitute of green secretion, and become blanched and etiolated. The same result attends all their other secretions; timber, gum, sugar, acids, starch, oil, resins, odours, flavours, and all the numberless narcotic, acrid, aromatic, pungent, astringent, and other principles derived from the vegetable kingdom, are equally influenced, as to quantity and quality, by the amount of light to which the plants producing them have been exposed." †

3031. To show the advantage that summer possesses over all the other seasons as regards light, it is only requisite to state its comparative duration in the respective months of the seasons, as we have divided the year, and it will then be seen that summer enjoys more than double the light of winter, a half more than spring, and a third more than autumn. Thus,

IN WINTER.			
November has	8	hours 10	minutes of light a-day.
December, ...	7	... 8	... ..
January, ...	7	... 44	... ..
Making a	<u> </u>		
mean of	7	... 41	... ..

* Kaemtz' *Complete Course of Meteorology*, p. 85, 92.
 † Lindley's *Theory of Horticulture*, p. 52.

IN SPRING.

February, has	9 hours 30 minutes of light a-day.			
March, ...	11 ... 49	...	...	...
April, ...	14 ... 9	...	...	...
Making a mean of	11 ... 49	...	...	...

IN SUMMER.

May, ...	16 ... 11	...	...	...
June, ...	17 ... 16	...	...	...
July, ...	16 ... 45	...	...	...
Making a mean of	16 ... 44	...	...	...

IN AUTUMN.

August, ...	14 ... 34	...	...	...
September, ...	12 ... 23	...	...	...
October, ...	10 ... 17	...	...	...
Making a mean of	12 ... 25	...	...	...

3032. Besides its existence for a greater number of hours each day, light is of greater intensity in summer than in the other seasons; because it is then transmitted through the atmosphere at a higher angle. The light of the sun or of the moon, in its passage from the meridian, is dazzling, whilst we can gaze at either body when near the horizon, because their rays cannot so easily penetrate through the thick stratum of atmosphere they have there to traverse, and many of them are absorbed. If it were possible to measure the intensity of solar light at different elevations, we might indicate the quantity of the absorption of those rays. The *actinometer* of Herschel and the *heliothermometer* of Saussure have been employed for the purpose, but unsuccessfully. Messrs Fizeau and Foucault, more recently, have tried to effect the purpose by Dagnerean plates, and they have measured the intensity of light by its *chemical* effects; and they regard it as very probable, that the luminous radiations of white light possess *optical* and *chemical* intensities in the same ratio. Light and heat are so intimately connected with the solar rays, that it is difficult to separate the two manifestations, so that the measure of the intensity of the calorific rays may also be regarded as that of the luminous. On considering the nature of this absorption of the solar rays by the atmospheric air, we must necessarily conclude that a portion only is absorbed—others are allowed to pass, and a third portion is reflected;

hence it is that they illuminate the vault of heaven, light up terrestrial objects on which the sun does not shine directly, and determine the insensible transition between day and night.

3033. *Heat*.—We have already considered the properties of heat from (158) to (162.) As heat always accompanies light with the solar rays, its intensity increases with that of the latter. The *actinometer* and *heliometer*, as well as the *pyreheliometer* of Pouillet, have all been employed to measure that intensity, and the results seem to be satisfactory. It would appear that a very large proportion of the heat of the solar ray is absorbed in passing through the atmosphere, and that the proportion is increased as the sun approaches the horizon. The results of some experiments made by Professor Forbes of Edinburgh, with M. Kaemtz, in 1832 at Brientz, and on the Faulhorn in Switzerland, are interesting, and rather startling—to learn that so large a proportion of the solar heat is absorbed by the atmospheric air. It appears that the bundle of calorific solar rays, on entering into our atmosphere, is composed of two sorts of rays; the one easily absorbable by the atmosphere, the other absolutely refusing all extinction; the former form nearly 0·8, and the latter 0·2 of the number. The law of the extinction of the rays of the first order is a geometrical progression, according to the hypothesis of Bouger, Kaemtz, &c., such that the *vertical* transmission through the atmosphere, taken from its base, the level of the sea, to its superior limit, reduces the 80 absorbable rays out of each 100 to 33. It follows from this theory, that the portion of the heat which is not absorbed in the case of vertical transmission, instead of being 75 per cent of the extra atmospheric heat, is only 53 per cent. Calculating serene and cloudy days, we thus see that the earth does not profit by more than a very small portion of the sun's rays that arrive at the atmosphere.*

3034. *Prognostics*.—In summer, when falling stars appear, some feature of the cirro-stratus may generally be seen about. They indicate the approach of a thunder-

* Kaemtz' *Complete Course of Meteorology*, pp. 150, 403.

storm. Fire-balls are not uncommon in warm summer nights, particularly when cirro-cumulus, cirro-stratus, and electric clouds abound.

3035. The *barometer* remains pretty stationary in summer, and comparatively high, any remarkable oscillation being a sudden fall before a violent wind from the S. W. It was an observation of Dr Dalton, that in summer, after a long continuance of fair weather, with the barometer high, it generally falls gradually, and for one, two, or more days, before there is much appearance of rain. If the fall be sudden, and great for the season, it will probably be followed by thunder.

3036. The *thermometer* is also steady and high, only indicating a great fall during a hail-storm.

3037. The air is clear and dry in summer, the clouds high, and the wind breezy. The changes from this state are occasioned by thunder and hail storms, and such changes are always sudden and violent.

3038. Animals are numerous in summer, and constantly in the air, and their covering of hair and feathers being peculiarly sensible to the changes of the atmosphere, give rise to such motions in the animals as are significant of approaching changes in the weather. Ducks, geese, all waterfowl, the guinea-fowl, peacock, crows, frogs, and sparrows, make much noise before a fall of rain. Bees roam but a short distance from their hives, and ants carry their eggs busily before rain. Magpies chatter much before wind. Spiders cover everything with their gossamer when the weather is to continue fine.

3039. Wild flowers indicate changes in the atmosphere as sensibly as animals. Chickweed expands freely and remains open fully, in a continuance of fine weather. When it, with the trefoil and convolvulus, contracts its petals, rain may be expected.

3040. Particular forms of clouds also indicate both steady and changeable weather, as thus:—

If woolly fleeces strew the heavenly way,
Be sure no rain disturbs the summer day.

And,

When clouds appear like rocks and towers,
The earth 's refreshed by frequent showers.

3041. The summer flowers consist of the ranunculus, goatbeard, harebell, scarlet lychnis, poppy, lily, and rose; and with numerous suchlike flowers the ground is literally covered with a profusion of beautiful creations.

3042. The metrical proverbs connected with the summer are not many.

MAY.

A cold May and a windy,
Makes a full barn and a findy.
May, comes she early, or comes she late,
She'll make the cow to quake.
Beans blow—before May doth go.
A May flood—never did good.
Shear your sheep in May—and shear all away.
A swarm of bees in May
Is worth a load of hay.
Look at your corn in May,
And you'll come weeping away.

JUNE.

Look at your corn in June,
And you'll come home in another tune.
Calm weather in June—sets corn in tune.

JULY.

A swarm of bees in July—is not worth a fly.
A shower in July, when the corn begins to fill,
Is worth a plough of oxen, and all belongs
theretill.
No tempest, good July!
Lest corn come off blue by.

3043. Among the superstitions prognostics connected with the weather still in existence, it is mentioned that if St Urban's day, 25th May, be fair, the Germans count on a good vintage, but if stormy, the reverse is said to be indicated. The forty days' rain ascribed to St Swithin, on the 15th July, is another well-known superstition, and may be ranked among those originating in atmospheric phenomena; for although the placing of the prognostic to the account of St Swithin is palpably the effect of ignorance and credulity, yet, if rainy weather occur about the 15th July, it will be of long continuance, as whatever weather sets in soon after the summer solstice is of long continuance, according to reference in many journals of the weather. The influence now ascribed to St Swithin used to be shared by St John the Baptist, and by St Paul

St Margaret's day, 20th July, used to have some curious superstitions connected with it, relative to the fecundating power of this lady's festival, quite at variance with her character as a virgin martyr. Probably it may be connected with the circumstance, that heifers are commonly put to the bull about this period of the year.

3044. Among many remains of augury extant at the present day, may be mentioned the common practice of nailing up dead kites, crows, owls, hawks, weasels, and other rapacious animals against the doors of barns, stables, and outhouses—a custom which originated in an endeavour to terrify their living compeers, and to warn them not to obtrude themselves.

3045. The Shepherd of Banbury's rules affecting the weather of the summer quarter are these:—"In summer or harvest, when the wind has been S. two or three days, and it grows very hot, and you see clouds arise with great white tops like towers, as if one were upon the top of another, and joined together with black on the nether side, there will be thunder and rain suddenly. If two such clouds arise, one on either hand, it is time to make haste to shelter. If you see a cloud rise against the wind, or side-wind, when the cloud comes up to you, the wind will blow the same way that the cloud came; and the same rule holds of a clear place, when all the sky is equally thick except one clear edge. If the clouds look dusky, or of a tarnish silver colour, and move very slowly, it is a sign of hail; and if there be a mixture of blue in the clouds, the hail will be small, but if very yellow, large. Small scattering clouds that fly very high, especially from the S. W., denote whirlwinds. The shooting of falling stars through them is a sign of thunder. Sudden rains never last long; but when the air grows thick by degrees, and the sun, moon, and stars shine dimmer and dimmer, then it is like to rain six hours usually. If it begin to rain from the S., with a high wind for two or three hours, and the wind falls but the rain continues, it is like to rain twelve hours or more, and does usually rain till a strong N. wind clears the air. These long rains seldom hold above twelve

hours, or happen above once a-year. If it begins to rain an hour or two before sun-rising, it is like to be fair before noon, and continue so that day; but if the rain begin an hour or two after sun-rising, it is like to rain all that day, except the rainbow be seen before it rains."*

3046. *Rainbow*.—As showers of rain fall most frequently in summer, so is the rainbow most frequently seen in that season. For the formation of a rainbow it is sufficient that the sun strike drops of water with its rays, and thus may be seen rainbows on clouds, and even on terrestrial objects. In order to see a rainbow, it is necessary that our face be turned away from the sun, and directed towards the rain-drops falling in the opposite direction of the heavens. What we then see is an arc composed of the prismatic colours, (191.) arranged in parallel and concentric arcs, the centre of which is formed by the shadow of the spectator's head. When two arcs appear, they are concentric on the same centre. In the interior bow, which is the more frequently seen, and the colours of which are the more vivid, the violet colour is within and the red without, and consequently, the red space is greater than the violet; and when two arcs appear, the outer one has the colours reversed, and consequently the violet rays predominate. The colours are more or less vivid in proportion to the intensity of the rays of the sun; and hence it is that lunar rainbows rarely exhibit the prismatic colours, being merely whitish or yellowish.

3047. The conditions under which the inner bow is formed, are, that the ray from the sun, in passing through the drop of rain, is refracted towards the opposite side of the drop, where it is reflected, and directed again by another refraction towards the eye. The different prismatic colours are reflected to the eye under different angles. The red ray, in these circumstances, subtends an angle of $42^{\circ} 23'$; and the violet ray only $40^{\circ} 29'$; so that the width of the arc is $1^{\circ} 54'$.

3048. When the ray is twice reflected on the back of the rain drop, before it reaches the eye, a double bow is observed;

* The Shepherd of Banbury's *Rules*, p. 27, 41.

and the angles formed by the different colours, in this case, is for the red $50^{\circ} 21'$, and for the violet $53^{\circ} 46'$; the width of the arc being $3^{\circ} 25'$.

3049. A third and a fourth bow may be formed; but the intensity of the light from these is so feeble that they are rarely seen. I have at times observed a triple bow.

3050. I have hitherto considered only a single drop of rain, and as it moves rapidly, the image from it can only last for a moment; but if a great number of drops fall in succession in the same direction, each of them will produce an image in the same place, and the sensation produced by the colours will remain permanent. It is evident that, as the various colours subtend different angles with the eye, only one person can see the same rainbow.

3051. When the sun is in the horizon, the bow appears a semicircle, with an apparent diameter of 41° . When the sun is 41° above the horizon, the apex of the bow will be a tangent to the plane of the horizon. If the sun is still higher, the bow will be seen projected on the ground, and the colours will be very pale. When the sun attains the height of 52° , a rainbow cannot be formed at noon in summer. When the head is elevated above the plane of the sun, as on a mountain, a larger portion of the arc is seen than the semicircle, in proportion to the height of the mountain, from whence may be seen the circle complete. When the head is elevated above the cloud, a red circle will be seen projected upon it, the rays of the sun from which will subtend an angle with the eye of $42^{\circ} 23'$, and the apparent diameter of the circle will also be $42^{\circ} 23'$.

3052. When a vividly coloured rainbow is projected on a dark cloud, the sky is much darker above than below the bow, which difference is the more striking when the sun is low. This is a phenomenon opposite to that connected with halos. If we follow the course of the sun's rays in a rain drop, we shall see that the drops situated above that in which the bow is formed do not send us the rays reflected

by their exterior surface, whilst the drops placed below do send them, and these, notwithstanding their divergence, vaguely illuminate the space situated beneath the bow.*

3053. The prognostics connected with the rainbow are the following:—After a long-drought the bow is a certain sign of rain; and after much wet, of fair weather. When the green is large and bright, it indicates rain; and when the red is the strongest colour, both wind and rain are indicated. If the bow break up at once, there will follow serene and settled weather. When the bow is seen in the morning, rain will follow; if at noon, settled and heavy rain; and at night, fair weather. The appearance of two or three rainbows indicates fair weather for the present, but settled and heavy rain* in two or three days after.

3054. The appearance of *twilight*, depending on the state of the sky, foretells to a certain extent the weather of the following day. When the sky is blue, and after sunset the western region is covered with a slight purple tint, we may be sure that the weather will be fair, especially if the horizon seem covered with a slight smoke. After rain, isolated clouds, coloured red and well illuminated, announce the return of fair weather. A twilight of a whitish yellow, especially when it extends to a distance in the sky, is not a sign of fair weather for the following day. We may expect showers when the sun is of a brilliant white, and sets in the midst of a white light, which scarcely permits us to distinguish it. The prognostication is still worse when light cirri, that give the sky a dull appearance, appear deeper near the horizon; and when the twilight is of a grayish red, in the midst of which are seen portions of a deep red that pass into gray, and scarcely permit the sun to be distinguished. In this case, vesicular vapour is very abundant, and we may calculate on wind and approaching rain.

3055. The signs drawn from *daybreak* are somewhat different. When it is very red, we may expect rain; whilst a gray

* Kaemtz' *Complete Course of Meteorology*, p. 440-4.

morning announces fair weather. The reason of the difference between a gray dawn and a gray twilight is, because in the evening the colour mainly depends on cirri, in the morning on a stratus, which soon yields to the rising sun; whilst the cirri become thicker during the night. If at sunrise there is enough of vapours for the sun to appear red, it is then very probable that, in the course of the day, the ascending current will determine the formation of a thick stratum of clouds.*

3056. According to the opinion of Dr Kirwan, after forty-one years' observations, it would appear that a *dry* summer was followed by a *dry* autumn 5 times; by a *wet* one, 5 times; and a *variable* one, 12 times. A *variable* summer was followed by a *dry* autumn only once; a *wet* one, 3 times; and a *variable* one, 12 times.

3057. After a *dry* summer, the probability of a *dry* autumn occurring, is as 5 to 16; a *wet* one, as 5 to 16; and a *variable* one as 6 to 16. After a *wet* summer, the probability of a *dry* autumn is as 1 to 5; a *wet* one as 3 to 5; and a *variable* one as 1 to 5.

3058. In the beginning of any year, the probability of a *dry* summer is as 16 to 41; of a *wet* one, 20 to 41; and of a *variable* one as 5 to 41.

3059. It may prove useful to such of you as may engage in pastoral farming, to know the prognostications observed in pastoral countries; and I cannot do this better than in the words of the Rev. Dr Russell, minister of Yarrow. It may be noticed that some of the prognostics have already been enumerated; but the concurrent testimony of certain prognostics, in high and low parts of countries, serve to confirm the more strongly the probability of their truth. "When there is a copious deposit of dew," observes Dr Russell, "and it remains long on the grass—when the fog in the valleys is slowly dissipated by the sun's heat, and lingers on the hills—when the clouds apparently take a higher station, and especially when a few cirro-strati appear loose

or slightly connected, lying at rest or gently floating along, serene weather may be confidently expected. A change of this settled state is presaged by the wind suddenly rising, by close continuous cirro-strati gathering into an unbroken gloom, and by that variety (of cirrus) known as the goat's-hair or gray-mare's-tail. Sometimes a few fleecy clouds skim rapidly between the superincumbent vapour and the earth's surface, and are the forerunners of snow or rain," (the scud). "Should the cirri not pass away with the immediate fall, but extend towards the horizon, and present their troubled edges towards the zenith, there will be stormy weather for some time. When a modification of the cirro-stratus is formed to leeward, thick in the middle, and wasting at both ends, with its side to the wind like a ship *lying to*, it indicates continued wind. After a clear frost, we sometimes see long whitish-coloured streaks of cirrus, (cirro-stratus,) whose two extremities seemingly approach each other as they recede from the zenith. This appearance is vulgarly called Noah's-ark; and if it point from S.W. to N.E., we expect a thaw from S.W. Small blackish boat-shaped clouds rising in the W., and moving sideways, indicate a thaw, with little or no rain. A short glare of red in the E., about sun-rising, portends a rainy and windy day. When the sky shines from the watery exhalations around the mid-day sun, rain or snow will soon follow; when it has a green appearance to the E. or N.E., frost and snow. A *crimson* red in the W., after sunset, indicates fair weather; a *purple* red indicates sleet. Atmospheric changes are more likely to happen a few days after new and full moon than in the quarters. The point when she changes seems to have little influence; if in the N.W. or N.W. by W., it is often succeeded by boisterous weather. When her horns are sharp and well-defined, we look for frost; when she is whitish and not very clear, for rain or snow. If the new moon seems to embrace the old, very stormy weather is likely to follow. . . . Halos are seen only when the cirro-strati are slightly but equally diffused over the sky; the sun or moon seems 'to wander through the storm,' which is at no great distance. One side of the halo is often

* Kaemtz' *Complete Course of Meteorology*, p. 413.

open or imperfectly formed, owing to the denseness of the vapour, and points to the quarter from which the storm is approaching. . . . Aurora borealis is most likely to appear in changeable weather, and is often followed by a S.W. wind. From the appearance of falling stars, it may be inferred that the equilibrium of the atmosphere, held probably by the agency of electricity, is destroyed. They generally forbode wind, and when many of them are seen, they are faithful though silent monitors, warning us to prepare, with the earliest dawn, for the coming storm. There is often much lightning in the night, both with and without clouds, which announces unsettled weather, especially if it be whitish in colour. . . . When the wind shifts to the west, after rain from S. or S.W., it generally fair's up, or there are but a few showers. Frost and snow from S.W. are forerunners of bad weather. If the wind turn suddenly from S.W. or S. to N.N.E., while this is accompanied with a smell resembling that of coal smoke, a severe storm will follow. . . . The lower animals, but such especially as are in a state of nature, or exposed in the open fields, are very susceptible of atmospheric changes. Sheep eat greedily before a storm, and sparingly before a thaw. When they leave the high parts of their range—when they bleat much in the evening or during the night, we may expect severe weather. Goats seek a place of shelter, while swine carry litter, and cover themselves better than ordinary, before a storm. Wind is foretold by the cat scratching a post or wall—and a thaw, when she washes her face, or when frogs come from their winter concealment. The gathering of grouse into large flocks, the diving of sparrows in dry dust, the fluttering of wild-ducks as they flap their wings, the dismal lengthened howl of sea-gulls in an inland place or around lakes, the mournful note of the curlew, the shrill whew of the plover, the *wheet-wheet-wheet* of the chaffinch perched upon a tree, the crowing of the cock at unusual times—all prognosticate rain or snow. When the fieldfare, redwing, starling, swan, snow-fleck, and other birds of passage, arrive soon from the north, it indicates an early and severe winter. When gnats bite

keenly, when flies keep near the ground, (shown by swallows, which feed upon the wing, flying low,) we look for wind and rain. But the most wonderful instance of atmospherical changes is upon those creatures that burrow in the ground. The earth-worm appearing in abundance indicates rain. In like manner, the mole seems to feel its approach, as, a day or two before, he raises more hillocks than usual; and when, after a long severe frost, he begins again to work, it will soon become fresh. The effects of electricity are well known both on the atmosphere and on animals; and the deposition of aqueous vapours, with the relaxing damp near the surface of the earth, which in certain states takes place, may give rise to this increased activity.*

3060. The strong and refreshing smell which is felt sometimes when showers first fall, after a long drought in summer, is not an invariable attendant on them, even under the circumstances which seem to indicate a strong positive electricity, such as the rising of the barometer in rain. The highly electrified water of summer thunder-storms produces this smell the strongest; and it is weakest with the cold, and perhaps even electric rain, which sometimes falls after the condensation of a spreading sheet of cirro-stratus into nimbus, with a cold atmosphere.

3061. I think every one, besides persons of a nervous temperament, have felt the truth of the following observations of Mr Forster, on the effects of certain states of the atmosphere on the hair of the head:—"In people of what are called nervous and susceptible constitutions," he says, "I have frequently noticed a remarkable variety in the appearance of the hairs on the head: they have appeared at times diminished in quantity; at others, superabundant. I have examined them carefully in each of their states, and found their apparent diminution to consist in the shafts themselves becoming smaller, drier, losing their tension, and lying in closer contact. I was once inclined to attribute their closer contact to a diminution of their electricity, by which they would become mutually repulsive: this, however, does

* *New Statistical Account of Scotland*—Yarrow, Selkirkshire, p. 31-4.

not seem sufficient to account for their decrease in size. The shaft may possibly be organised throughout, and its enlargement may be caused by an increased action of its vessels; there may also be an æriform perspiration into its cavity, on an increase of which it may be more distended; and the increased size and tension of the shaft may result from the co-operation of these two causes. The increased size, strength, and tension of the hair, appear to accompany health, while the opposite state seems to be connected with disorder. The sympathies between the skin and stomach have been frequently adverted to by physiologists: the skin has been found to be alternately dry and hot, moist and hot, dry and cold, moist and cold; and these varieties have been attributed to varieties in the state of the stomach, between which and the skin a very direct sympathy is believed to exist.*

3062. Variety of states in the hair of animals is frequently observed in all classes of the domesticated animals; and the difference is invariably ascribed either to the pleasant or disagreeable state of the air, or to the functional derangements or activity of the stomach and bowels. As the food in pasture is nearly always the same, any change of the condition of the hair of animals in summer on pasture, must be ascribed to the changes observable in the state of the atmosphere; and from the recognised sympathy existing between the skin and the stomach, the changes in the state of the hair may safely be ascribed to arise from the altered states of the air.

3063. Mean of the atmospherical phenomena occurring in summer is as follows:—

Mean of the barometer in England in	
May, . . .	30·03 inches.
June, . . .	29·98 --
July, . . .	30·04 --

Mean of summer, 30·05 --

Mean of the thermometer in England in

May, . . .	54°·6
June, . . .	61°·3
July, . . .	63°·8

Mean of summer, 59°·9

Tension of vapour for 59°·9=26·83.

Mean fall of rain in England in

May, . . .	1·37 inches.
June, . . .	2·71 --
July, . . .	1·66 --

Mean of summer, 1·91

Prevailing winds in England in

May, . . .	E. to N.
June, . . .	W. by N. to N.E.
July, . . .	W. by S. to E.

Number of storms in the west of Europe in summer is 52·5 in 100.

Number of hail-storms in England in summer is 3 in 100.

Aurora borealis observed in

May, . . .	184 times.
June, . . .	65 --
July, . . .	87 --

Number of fire-balls seen in

May, . . .	46
June, . . .	20
July, . . .	47

The least number of fire-balls occurs in June, and doubtless the length of the days in summer allows a great many of these meteors to pass unperceived.

3064. No circumstance shows so strongly the inconvenience to farming of arranging spring and summer according to the calendar months, than in directing the sowing of the numerous sorts of crops, which must be undertaken at the end of the one and the beginning of the other season. The sowing goes on progressively of one crop after another, from the sowing of beans in February to that of turnips at the end of June; and all that period may be regarded as spring, in as far as field operations are concerned, and yet the latter date brings us a great way into summer. This being the case, many of the crops may as well be sown at the commencement of summer as at the end of spring. Thus flax may be sown in April as well as May, and kohl-rabi may be begun to be sown in March as well as in May, according to the mode of culture followed. As regards the crops, therefore, about to be sown at the commencement of summer, it must not be deemed an absolute requisite to sow them at that season. The proper time for sowing each crop is specifically mentioned, irrespective of the place

* Forster's *Researches about Atmospherical Phenomena*, p. 180.

it may happen to occupy in the spring or summer season, as we have divided these. The real point to attend to is, the order of succession in which the different crops follow each other; and which they invariably do every year. With this explanation, the description of the sowing of the crops will be continued.

3065. All the root crops are sown just now, beginning with kohlrabi, and ending with the turnip. The land for all these is worked, cleaned, drilled, dunged, and sown. The culture of the turnip is a most important and busy occupation, affording much occupation in singling and hoeing the plants the greater part of the summer.

3066. The period has now arrived for disposing of the fat cattle to the butcher or dealer, as they are never put to grass. The fat sheep are also disposed of, except when it is desired to take off their fleece before parting with them, when they are allowed to pasture until the season becomes warm enough for them to be shorn.

3067. Before any of the stock is put on grass, it is the duty of the hedger to mend every gap in the hedges, and to have the gaps in the stone walls, and the gates of the fields in grass put into repair.

3068. Young cattle, sheep, and cows, are now put on pasture, to remain all summer. Cattle and sheep graze well together, as the former bite the grass high, and the latter, following, bite it still lower. For the same reason, horses and cattle graze well together. As both horses and sheep bite low, they are not suitable companions on pasture; and horses, besides, often take delight in annoying sheep, by biting and kicking them.

3069. Sheep-shearing is never commenced until the weather becomes as warm as not to chill the sheep, after the privation of their coats of wool.

3070. Horses now live entirely another sort of life, being transferred from the thralldom of the stall-collar in the stable to the perfect liberty of the pasture-field, and none of the animals enjoy themselves there more heartily.

3071. The brood mare now brings forth her foal, and receives immunity from labour for a time.

3072. Hay-making is represented by poets as a labour accompanied with unalloyed pleasure. Lads and lasses are doubtless then as merry as chirping grasshoppers; but haymaking is in sober truth a labour of much heat and toil, the wielding of the hayrake and pitchfork in hot weather, for the live-long day, being no child's play.

3073. The separation of the lamb from the ewe is now effected, and the marks of age, sex, and ownership are stamped upon the flock.

3074. The forage-plants on farms in the neighbourhood of towns are now disposed of to cow-feeders and carters.

3075. Butter and cheese are made on dairy-farms as often as the requisite supply of milk will warrant.

3076. Summer, of all the seasons, is the most appropriate for the farmer to make serious attacks upon weeds, those spoilers of his fields and contaminators of his grains. Whether in pasture, on tilled ground, along drills of green crops, amongst growing corn, or in hedges, young and old, weeds are daily exterminated; and the extermination is most effectually accomplished by the minute and painstaking exertions of female field-workers; for which purpose they are provided with appropriate implements.

3077. This is the season in which all manner of insects attack both crops and stock, much to their injury and annoyance.

3078. Although yet early, preparations are made in summer for the next year's crop. The fallow land is worked, cleaned, and manured, and perhaps also limed, to be in readiness for the wheat seed in autumn.

3079. The top-dressing of growing crops, with specific manures, is a recent introduction into farming. The subject is not yet matured, from want of sufficient experience

in the peculiar action of each specific, but enough is already known of that to encourage the farmer to employ them, in the fittest state of the weather and the crops.

3080. The hours devoted to field-work in summer vary in different parts of the country. On the Borders it is the practice to go as early as 4 o'clock in the morning to the yoke, and the forenoon's work is over by 9, and time is given for rest in the heat of the day. The afternoon's yoking commences at 1 o'clock, and continues till 6. Thus 10 hours are spent in the fields. But in other parts of the country, the morning yoking does not commence till 6 o'clock, and, on terminating at 11, only two hours are allowed for rest and dinner till 1 o'clock, when the afternoon's yoking begins. In most places the afternoon yoking does not commence till 2 o'clock, and, finishing at 6, only 9 hours are spent in the fields, or it is continued to 7 o'clock. In other parts, only 4 hours are spent in the morning yoking, when the horses are let loose at 10 o'clock, and, on yoking again from 2 to 6 in the afternoon, only 8 hours are devoted to work in the fields, the men being employed elsewhere by themselves for 2 hours. This practice is pursued where the ploughmen are made to do the work of field-workers, and a large number of draughts are kept. Perhaps the best division of time is to yoke at 5 o'clock in the morning, loose at 10, yoke again at 1, and loose at 6 in the evening, giving 3 hours of rest to man and horse at the height of the day, and 10 hours of work in the field.

3081. Day-labourers, when not working along with horses, as well as field-workers, usually work from 7 to 12, and from 1 to 6 o'clock in the evening, having one hour for rest and dinner. When labourers take their dinner to the field, this is a convenient enough division of time; but when they have to go home to dinner, one hour is too little for dinner and rest between the yokings—and rest is absolutely necessary, as neither men nor women are able to work 10 hours without more than an interval of an hour. It would be a better arrangement for field-workers to go to work at 6 instead of 7, and loose at 11 instead of 12, when they have to go home to dinner; but if they take their dinners to the field, one hour is sufficient for rest and din-

ner at the same time. When field-workers labour in connexion with the teams, they must conform with their hours of labour.

3082. The long hours of a summer day, of which at least ten are spent in the fields—the ordinary high temperature of the air, which suffuses the body of the country labourer in constant perspiration—and the fatiguing nature of all field-work in summer, bear hard as well on the mental as the physical energies, and cause him to seek rest at a comparatively early hour of the evening. None but those who have experienced the fatigue of working in the fields, in hot weather, for long hours, can sufficiently appreciate the luxury of rest—a feeling truthfully depicted in these beautiful lines:—

“Night is the time for rest.

How sweet, when labours close,
To gather round the aching breast
The curtain of repose—

Stretch the tired limbs, and lay the head
Upon one's own delightful bed!”

JAMES MONTGOMERY.

3083. Every operation, in summer, requires the constant attention of the farmer. Where natural agencies exert their most active influences on vegetation, he requires to put forth his most active exertions to cooperate with the very rapid changes they produce. Should he have, besides, field experiments in hand, the demands upon his attention and time will be the more urgent, and he must devote both, if he would reap the greatest advantage derivable from experimental results.

3084. Summer is the only season in which the farmer has liberty to leave home without incurring the blame of neglecting his business, and even then the time he has to spare is very limited. Strictly speaking, he has only about a fortnight between finishing the fallow and the commencement of harvest, in which to have leisure to travel. Such a limitation of time is to be regretted, as a journey once a year to witness the farm-operations conducted in other parts of the kingdom, would enlighten him on many uncertain points of practice. Such an excursion could not be undertaken by a farmer, who is generally a man of observation, without his acquiring confidence in good and receiving conviction against bad practices. A journey

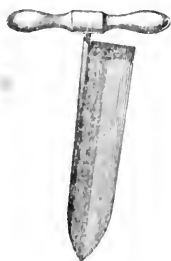
exhibits mankind in various aspects, elevates the mind above local prejudices, and affords a clearer understanding of places and customs, when reading about them in the publications of the day. As husbandry is a progressive art, a ramble of a few weeks in different parts of the country cannot fail to enlighten the most experienced farmer, much beyond what he can observe around him and peruse in books by always remaining at home. By intrusting the fallow operations to his work people, he might in occasional seasons have as much as a month to spend in useful travel.

ON THE HAY GIVEN TO FARM HORSES.

3085. The hay-stack is never broken in upon until the horses get hay in spring, and this is delayed a longer or shorter time, according as there is other nourishing food for horses on the farm. Where good bean-straw abounds, the hay may be saved until later in the spring, when that sort of straw becomes too dry; but on farms where no beans are grown, the horses should have hay whenever the seed-time is commenced, whether with spring-wheat or with oats. The site of the hay-stack in the stack-yard S, Plate II., is at *n*, opposite the hay-house H., and adjoining the work-horse stable C. The site of the hay-stack may be seen in the isometrical representation of the stack-yard in Plate I.

3086. As much of the stack is brought in as will fill the hay-house, and the hay is thence distributed to the horses. Each portion of the stack cut off should be 4 or 5 feet broad, and the implement used for doing it is the *hay-knife*, fig. 242, which represents its usual form.

Fig. 242.



THE HAY-KNIFE.

It will be observed in the figure, that the line of the back of the blade is not at right angles to the handle, a position which gives the cutting edge of the knife an inclination to the line of section, and consequently affords it, in its downward stroke, a force to cut the straws of hay in succession which it

could not otherwise have. The person who cuts the stack is usually the steward, and in using the knife he kneels upon the part he is cutting off, with his face to the body of the stack. This form of knife requires considerable strength in its use, and unless the edge is kept remarkably keen with a whetstone, and the hay firm, it makes bad work. The hay-knife I prefer is of the form of the dung-spade, fig. 191, which, being used standing, is wielded with much more force, and makes a deeper cut; and, having two edges, it cuts equally well to the right and left, whereas this knife cuts only to the right. In cutting off a dace or breadth of hay, the end of the stack should be left in a perpendicular form, and horizontally straight. When the dace is not all cut down to the ground, straw should be placed on the top of the portion left, to preserve the hay becoming wetted by rain. The field-workers carry the hay into the hay-house as the cutter throws it down with a fork, and build and tramp it in regular mows, in the manner straw is mowed in the straw-barn from the threshing-machine, (1763,) to make it easier for the ploughmen to take the hay in armfuls to their horses.

3087. Hay is supplied to work-horses at will; and, as I have already said, when treating of their feeding in winter, strong ones will eat about 30 lb. a-day, besides their corn, which may be 10 lb. more, (1444.) These quantities imply that the hay and corn are given in their natural state, but when cooked the quantities vary, as has been stated in (1438 and 1444.)

3088. Considerable waste of hay is incurred in the hay-racks, fig. 105. The ploughmen stuff the rack not only full, but squeeze the hay firm, from a mistaken notion that they cannot give too much at a time to their horses; but when horses find hay in a compressed state, and are unable to select the morsels they like, they toss some upon the litter, which, after being trampled on, is thrown into the dung-yard. The cattle there eat it, and prefer it much to straw, because it is hay, and has acquired a saline taste from the stable, so it cannot be said to be entirely lost; still, if it is desired to give hay to the cattle also, it should be given them in a clean state and proper

manner, rather than in this way. To avoid such waste, therefore, small quantities of hay should be put into the racks at a time, and frequently; but the surest way to prevent waste of food is to chop the hay and bruise the corn.

3089. Young horses should also receive hay after the stack has been broken up, straw becoming too hard and dry after March; and hay serves, besides, to improve their condition, and prepare them for grass.

3090. Feeding cattle never receive hay in Scotland, being considered too expensive food for them. In England, meadow hay is given to feeding cattle either alone, with some straw, but more frequently chopped hay and straw together, or in union with oil-cake, or with linseed prepared. In dairy farms cows always receive hay after having calved, and it is partly given them in the form of steamed chaff, and partly as dry fodder.

3091. In Holland the horses in winter, and at all times when not on grass, receive chopped hay and straw, with not much oats. In Belgium, about Bruges, farm horses receive about 35 lb. of hay and 7 lb. of oats a-day, and in lieu of 15 lb. of hay, 73 lb. of carrots. Near Courtray, 10 lb. of straw is given with 15 lb. of hay and 7 lb. of oats. Their drink is also nutritive, being composed of water with some oil-cake dissolved in it, and sweetened with rye-meal or buck-wheat flour.*

3092. According to Boussingault, hay may be assumed as the most common or universal of all kinds of fodder. It is in some sort the staple food of the animals that are particularly attached to an agricultural concern, and may therefore be appropriately made the standard of comparison for all other kinds of food or forage. Hay, however, varies greatly in point of quality, but in an average of kinds and states, the proportion for the standard should consist of 1.15 percent of azote, and 11 per cent of water—that is, about 8½ per cent of albumen and gluten, and the remainder woody fibre. It is this last ingredient which gives an important value to hay as a fodder, for, independently of the circumstance that the stomachs of animals are able to digest a certain proportion of the woody fibre, its bulk is necessary for the digestion of the more nutritious parts of itself and of other food, such as oats,

which are administered at the same time. Vegetable food of every description has nearly the same specific gravity, which is little above that of water. The bulk of the allowance therefore depends upon its weight, and it will thus be perceived that a highly nutritious food, which for this reason would occupy little space, would be objectionable. Thus a cart-horse belonging to M. Boussingault, required from 26 lb. to 33 lb. of solid food every day, and about the same quantity of water. The bulk of this allowance, when masticated and brought to a state to be swallowed, is more than 9½ cubic feet. Now, if a few times more nutritive food, as oil-cake, were substituted, its bulk would be reduced to 5¼ cubic feet. The animal would not feel satisfied with this last allowance—it would still feel hungry, and the food, in so concentrated a state, would disagree with it. On the other hand, if food of much less nutrition were substituted for the hay, such as wheat straw, the allowance that would afford the same degree of nourishment would become too bulky to be eaten in the course of a day. It is therefore absolutely necessary to take the bulk of the food to be allowed into consideration: the belly must be filled; whatever may be the nutritive quality of any article, it must be given in a certain quantity; and in the case of such a substance as oil-cake, the consumption to fill the stomach would cease to be in any kind of proportion to the nutritive equivalent. The best food for horses has long been admitted to be hay and oats in combination, neither article alone having the same happy effect that the two together produce. Hay alone would be too bulky, oats alone would not be bulky enough; but the horse is not particular in his food, as barley in the southern countries replaces oats and answers equally well—though it may reasonably be doubted that oats and hay might be replaced by roots and tubers. Experience, however, has proved that a cart-horse may have half his allowance in roots and tubers, and be supplied with sufficient nourishment. M. Boussingault has found that 100 parts of good meadow hay is equal to the following quantities of roots usually given to horses:—

To 280 parts of potatoes by analysis = 315 by experiment.			
280 ..	Jerusalem artichokes }	.. = 311	..
400 ..	Mangold- wurzels, }	.. = 546	..
400 ..	Swedes,	.. = 676	..
400 ..	Carrots,	.. = 382	..

It may be concluded that the nutritive equivalent of the potato, mangold-wurzel, Jerusalem artichokes and carrots, as they are inferred from the amount of azote they contain, may be adopted without detriment to the health of horses. If they err at all, it is that they assign equivalents somewhat too high, making their actual nutritive power less than these numbers give it—so that, a portion of the hay of the standard allowance being substituted for its equivalent of root, the diet will be improved.†

* Radcliffe's *Agriculture of Flanders*, p. 259.

† Boussingault's *Rural Economy*, Law's Translation, p. 522-48.

3093. The composition of the ash of hay is as follows :—

	Meadow-hay. BOUSINGAULT.	Rye grass hay. THOMSON.
Potash,	18.11	29.03
Soda,	1.35	2.44
Limé,	22.95	16.36
Magnesia,	6.75	8.82
Oxide of iron, alumina, &c.,	1.69	0.64
Phosphoric acid,	5.97	5.63
Sulphuric acid,	2.70	3.08
Chlorine,	2.59	2.97
Silica,	37.89	31.03
	100.00	100.00
Percentage of ash } in the dry state, }	6.00	6.20
		5.89.

3094. *Good old* hay is long and large, hard and tough; colour inclining to green rather than to white; has a sweet taste and fragrant smell, and when infused in hot water produces a rich dark-coloured tea. In damp weather good hay absorbs moisture, and becomes heavier. A truss of good old hay weighs 56 lb.

3095. *Bad* hay will change a horse's appearance in two days, even with an unlimited quantity of corn. The kidneys are excited by it to extraordinary activity. The urine, which in this disease is always perfectly transparent, is discharged very frequently and in copious profusion. The horse soon becomes hidebound, emaciated, and feeble. His thirst is excessive. He never refuses water, and he drinks as if he would never give over. The disease does not produce death, but it renders the horse useless, and ruins the constitution. *Musty* hay is said to be bad "for the wind," and it is certainly so for every part of the body.†

ON THE SOWING AND SUMMER TREATMENT OF FLAX.

3096. The flax plant requires a deep mellow loamy soil, abounding in vegetable matter, and equally removed from strong clay and thin gravel—on the former the plant would grow too strong and branchy,

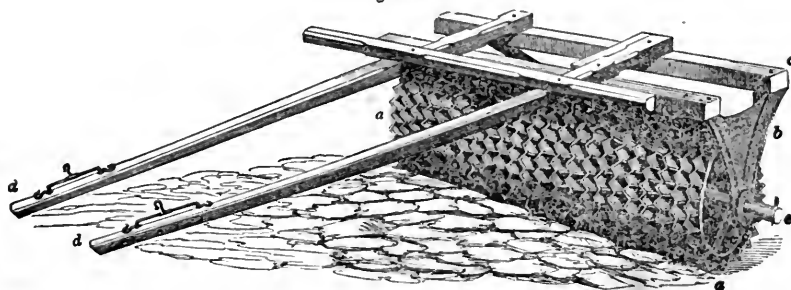
yielding coarse fibre, and on the latter the crop would be too scanty. Soil in too high a condition also causes flax to grow rank and branching, and the fibre coarse.

3097. The finest condition of the flax crop is best attained by sowing it after a corn crop or after lea—as, after a green crop that has been manned, it grows too rank and coarse. When grown after lea, flax may be raised on stronger soil than after any cereal crop.

3098. Whether after cereals or lea, the land to be cropped by flax should be ploughed early in autumn, to receive the full influences of the winter frost, as it cannot be in too fine a state of pulverisation for receiving the flax seed. To obtain this state of the soil, the cross-ploughing should be executed as early as possible in spring, (2613,) taking care not to do it in wet weather, or when the soil is in a wet state, as the least dry weather afterwards will render the soil hard and difficult to pulverise. Any clods left on the surface, after a double turn of the harrows, should be reduced by rolling; but there are other implements better adapted for pulverising the soil than the smooth roller, fig. 222.

3099. *Crosskill's clod-crusher*.—This is one of the most efficient implements of its class, and is represented in perspective in fig. 243, where *a a* is the roller, six feet in length, and 30 inches in diameter; *b a* east-iron end frame, at each end of the roller, bolted to the wooden frame *c c*, to which are bolted the horse shafts *d d*.

Fig. 243.



CROSSKILL'S CLOD-CRUSHER.

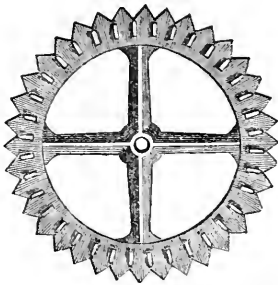
* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 390.

† Stewart's *Stable Economy*, p. 184-6.

The frame ends *b* are placed upon the axle *e*, the ends of which are prolonged to form arms on which wheels are placed, and kept on by means of cotterels, for the removal of the roller from one field to another. When the wheels are to be placed or removed, a hole is dug in the ground under each wheel, while the roller rests on the ground.

3100. The roller consists of a number of toothed wheels, supported on four-feathered arms, and an eye formed in the centre fitted to move easily on the axle *e* of the roller. Fig. 244 shows a side view of one of those wheels, by which its action upon the soil may be easily understood. When such a great number of angles, acting like so many wedges, are brought into contact with the indurated clods, they infallibly split them into numerous fragments, and the repetition of the process produces a well pulverised surface. The effect is quite different from that of the plain roller, fig. 222, with which, if a clod does not crumble down at once with its pressure, it is forced into the soil in a solid state.

Fig. 244.

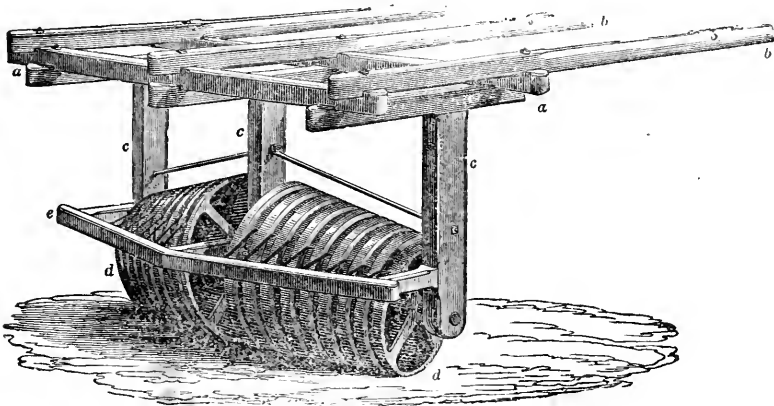


SIDE VIEW OF ONE WHEEL OF THE CLOD-CRUSHER.

3101. This implement has been but partially used by Scottish farmers within these few years, though it is extensively used in England—perhaps on account of the much greater extent of clay soils, which are most subject to induration. Where the implement has been used in Scotland, the results have proved equally favourable on strong and light soils—in pulverising the former and consolidating the latter. The price is a bar to its introduction into Scotland, as the smallest size is £18. The weight of the implement is 26 cwt.; it forms a good draught for two horses, and frequently for three.

3102. *Hepburn's double conical land-roller.*—Another implement of this class is the double conical roller, invented by J. Stewart Hepburn, Esq. of Colquhalzie, near Creiff, Perthshire. The leading feature of this implement is to give the roller a conical form, and to add to it a series of transverse parallel flutings carried round the conical surface. Two of these conical frustums are placed in one frame, base to base, but having their axes so inclined that the fore part of the periphraisis, and also those parts which lie on the ground, shall be in a straight line. Fig. 245 represents this implement in perspective in the most approved form, where *a a* is the framework, similar to that of the common land-roller, fig. 222, surmounted by three horse shafts *b b b*, for yoking two horses abreast. The three pendant bars *c c c* carry the axles of the two cones *d d*, in-

Fig. 245.



HEPBURN'S DOUBLE CONICAL LAND-ROLLER.

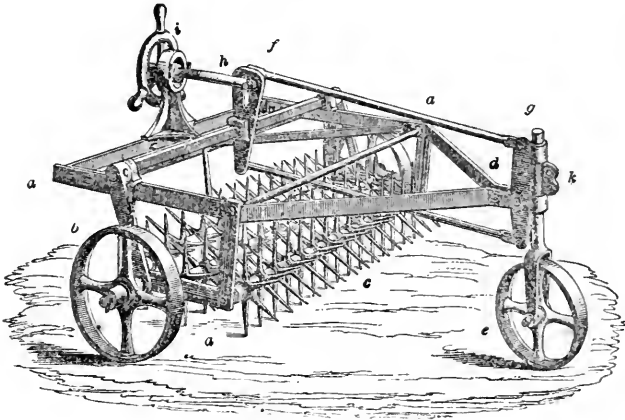
clined as above described. A light frame *e* is attached to carry the scrapers which clear the flutings of adhering earth.

3103. The effects of this form of roller upon the surface are peculiar and important. While the smooth cylindrical roller acts merely by its pressure on the rough soil, the conical form as here arranged will, besides acting by direct pressure, produce a strictly pulverising effect, for the cones having a constant tendency to

move outward in a circle, and being restrained by the bearings in which they revolve, their surface will produce a crushing and abrading action well adapted for the pulverisation of the soil.*

3104. *Norwegian harrows.*—Another pulverising implement which has recently been introduced into practice, is the Norwegian harrows. Fig. 246 is a view in perspective of these harrows, where *aaa* is a frame, supported by two wheels *b*,

Fig. 246.



THE NORWEGIAN HARROWS.

which give locomotion to the machine. The lower bars of the frame *a* support three axles, in the same plane, threading a number of discs containing each 6 long rays *c*, which, being loose, revolve round their centres by successive insertions of their points into the ground. The frame *a* is prolonged in a triangular form to *d*, where it is supported by the pivot-wheel *e*. The apparatus *fg*, for lowering and raising the axles of the rays *c*, to give them a deeper and shallower insertion into the soil, is moved by the screw *h*, which is put in motion by turning the winch by its handles *i*. The horses are attached at *k*.

3105. The action of this machine is to reduce large clods into very small ones, by the insertion of the points of the rays *c* into them, to split them into pieces by their reiterated action. The larger clods are split into smaller pieces by the first row of rays, the second row splits these

into smaller ones, and the third row splits those smallest pieces into still smaller ones; so that, by the time the clods have undergone those various splittings, they are probably sufficiently pulverised; but if not, they may be so by another similar process of splitting.

3106. *Swedish land-roller.*—A pulveriser of the soil has lately been introduced into this country by Mr James Slight of Edinburgh, from Sweden, where it is extensively and successfully used in the farming of Gottland. In construction it is simply the skeleton of a cylinder formed of wrought-iron ribs, of a triangular form, placed longitudinally round two cross-armed rings, which are the ends of the cylinder, and through the centres of which passes the axle upon the ends of which a frame-work and shaft, similar to the common land-roller, fig. 222, are mounted. It is made in two lengths, for the conve-

* *Prize Essays of the Highland and Agricultural Society*, vol. xi. p. 471.

nience of turning round, and as the ribs are placed with their angles outwards at $2\frac{1}{2}$ or 3 inches, they are well adapted for pulverising clods. In the trials that have been made of this roller in the neighbourhood of Edinburgh, in 1849, it has proved its efficiency as equalling any other of its class.

3107. The soil being thus well pulverised, it should be finely harrowed, and rolled smooth with the land-roller, fig. 222, before being sown with the linseed. Linseed being a very slippery seed, and very difficult to be sown by hand, it is apt to be *laddered*, (2320,) and I have never heard of it being sown with a machine. It should be taken hold of by the thumb and two foremost fingers, like grass seeds, (2647,) and thrown forward in sharp casts, with short quick steps, and, being dark coloured, may easily be observed to fall upon the rolled ground. It is thus usually sown broadcast.

3108. The quantity of seed used depends on the object of sowing the crop. If for the fibre alone, the seed should be thickly sown, from 2 to $2\frac{1}{2}$ bushels to the acre; if for seed, less seed should be sown; and if for both fibre and seed, perhaps 2 bushels are ample.

3109. The seed should be covered very shallow in the soil, not exceeding half an inch; and the best implement for covering it is the grass-seed harrow, fig. 232.

3110. Linseed may be sown at any time, according to the state of the weather, from the middle of March to the first week of May; and perhaps the best time is about the middle of April.

3111. Linseed is of an oblong lenticular form, having as smooth a surface as to appear oily, and it should feel heavy and seem plump and fresh. It is obtained of the finest quality for sowing from Russia, of the variety called *Riga kindt*, which the Dutch obtain for their sowing seed from Riga. It weighs about 52 lb. per bushel, and affords 840 seeds to 1 drachm weight, (1323.) As good seed is of great importance in the success of the flax crop,

linseed beyond a year old should never be sown.

3112. To facilitate the weeding of the flax crop, it has been recommended to sow the seed in rows, in the ribs formed by the small plough, fig. 230; but it is obvious that such a practice would cause the plants along the outer sides of the rows to throw out branches very much to the injury of the fibre.

3113. To save the weeding of the flax crop altogether, it has been recommended to sow grass seeds amongst it; but those who recommend this practice, do not consider that it is bad husbandry to sow grass seeds with any crop that follows a corn crop without manure, or with one after lea.

3114. Although the flax crop does not bear dung to be applied before it is sown, a top-dressing of bone-dust of 10 or 12 bushels to the acre, is recommended after a white crop, and is said to make the fibre finer.* The Belgians profusely top-dress their flax ground with liquid manure, in which have been dissolved both rape-cake and nightsoil, to the extent of 2480 gallons to the acre.† Were a top-dressing applied to the flax crop, containing its essential inorganic ingredients, as phosphoric acid, magnesia, and potash, (1263,) I have no doubt it would tend to produce a superior quality of fibre or seed. New-limed land is detrimental to the flax crop.

3115. The only care required by the flax crop in summer is to keep it free of weeds, which will probably appear above ground as soon as the crop itself; and as soon as the flax plant shall have attained the height of an inch, so as to be identified from weeds, the ground should be freed of them. The flax being best cultivated in broadcast, and thickly sown, the only practicable way of weeding the ground is with the hand; and as the plant is not of a succulent nature, but firm and elastic, even when young it is not injured by the weeders kneeling or lying upon it in the act of weeding. The weeding should be done effectually, and if so once done, the weeds will not again

* Warnes' *Suggestions for Fattening Cattle on Native Produce*, p. 8, 1st edition.

† Radcliff's *Agriculture of Flanders*, p. 42.

trouble the crop in clean ground, before it grows beyond danger; and although hand-weeding costs several shillings per acre, according to the state of the ground, the increased value of the crop will more than repay the cost.

3116. Besides the common surface and root weeds which infest the soil, according to its nature, there are others specially found amongst flax: of these, one is the common Gold of Pleasure, *Camelina sativa*, the seed of which is imported among the flax-seed, and the grown plant may be known by its attaining from two to three feet in height, having small yellow flowers, and very large pouches on long stalks.

3117. But a more troublesome weed than this is the flax-dodder, *Cuscuta Europæa*, inasmuch as it adheres parasitically to the flax plant, and materially injures its fibre; while the Gold of Pleasure may be pulled out separately from the flax. The habits of the flax-dodder are these:—“It is a plant which germinates in the ground, and sends up a slender threadlike stem, which, twisting itself about, soon touches one of the stems of the flax amongst which it is growing. As soon as this takes place, the dodder twists itself round the flax, and throws out from the side next to its victim several small processes, which penetrate the outer coat or cuticle of the flax, and act as suckers, by which the parasitical dodder appropriates to its own use the sap which has been prepared in the flax, upon which the growth of the flax depends. The dodder then separates itself from the ground, and relies solely upon the flax for its nourishment, producing long slender leafless stems, which attach themselves to each stem of flax that comes in their way. Thus large masses of the crop are matted together, and so much weakened as to become almost useless. This plant produces great quantities of seed, which is usually threshed with the flax-seed, and sown again with it in the succeeding year. Several years since, I took considerable trouble to ascertain if all foreign flax-seed was mixed with that of the dodder, and was led to the conclusion that the American flax-seed is nearly free from this pest, and that that from Russia,

and especially from Odessa, is peculiarly infected with it.”* A thorough weeding will remove this pest from the soil before it has the power of injuring the flax-plant.

3118. The flax, *Linum usitatissimum*, from the Celtic *Lin*, a thread, is in the class and order *Pentandria Pentagynia* of Linnæus; in the order *Lineæ* of the natural system of Jussieu; and in the class *Hypogynous Exogæus*; alliance 36, *Geraniales*; order 183, *Linacææ*; genus 1 *Linum*, of the natural system of Lindley. The plant is scattered more or less over most parts of the globe.

3119. The meal of the seed of the common flax is used for poultices. The infusion is demulcent and emollient. The oil, mixed with lime water, has been a favourite application to burns. The tenacious and delicate fibre obtained from this plant forms the most beautiful of our linen fabrics.

3120. The oil extracted from linseed (1323) is much used in the arts. The best is that which is cold drawn. The warm drawn is obtained by heating the seed by steam to a temperature of 200° Fahrenheit; and as the heat liquifies the oil, no doubt more is obtained of it by this process than the cold one. The oil is expressed by putting both the cold and the hot seeds into flannel bags, and subjecting them to enormous pressure by means either of wedges driven by weighty hammers, or of the hydraulic press, (107.) This oil may be used in fattening cattle, (1322.) Cold-drawn linseed oil is the best substance for polishing furniture of mahogany.

3121. The compressed husk left in the bag, after the expression of the oil, takes the form of a cake—the *oil-cake*. The English cake weighs about 3 lb., and sells from £10 to £11 per 1000. The oil-cake imported from Denmark, Holland, or America, is sold from £7 to £9 per ton. At £7 the price is three farthings the pound, and at £11, it is about one-penny two-tenths. At 1d. the pound the price is £9, 6s. 8d. per ton. That which comes from Flensburg in Schleswig-Holstein is esteemed the best of the foreign cake. The machinery abroad being generally inferior to that of this country, the foreign cake may be supposed to contain more oil than the English, which conjecture chemical analysis has confirmed, (1268.)

3122. Mr James Bruce, Waughton, East Lothian, made experiments in 1844, to ascertain the comparative value of English and foreign oil-cake in the feeding of sheep; and on two lots of twenty dimmots each, having as much Swedish turnips as they could eat, with 16 oz. each daily of oil-cake, which was as much as they would eat, one lot on English and the other on foreign cake, from the 1st of January, when the experiment commenced, to the 1st March, the increase of weight from the English cake over that of the

* *Gardeners' Chronicle* for 10th February 1844, p. 189.

foreign was as 209 lb. are to 150 lb., after a consumption of 1182 lb. of cake by each lot. But to show the uncertainty of results from only one experiment, other two lots of dimnots of 20 each were fed in the same manner, and these would not eat more than 13 oz. of each kind of cake daily, and the result of this experiment was the converse of that of the former—namely, the increase from the foreign cake over that of the English was as 207 lb. are to 167 lb., after a consumption of 880 lb. of cake by each lot. So the results of the one experiment neutralise those of the other, while the opposite nature of the results could not be accounted for, farther than the less consumption of 3 oz. daily by each sheep, of cake, might possibly have some effect on its relation to the quantity of turnips consumed, and this relation may have affected all the sheep alike. Such a suggestion may be regarded as of trifling import upon the general condition of an experiment; but when we know that a very slight difference of food or of exercise may affect the functions of the animal economy at any time, we should not regard such a difference affecting animals as of trifling importance.

3123. In another experiment by Mr Bruce, to ascertain the effect of oil-cake on the quality of manure voided by cattle fed on turnips, on comparing the produce, of turnips from 20 cubic yards of dung in the common state with 20 cubic yards containing 26 lb. of cake in each cubic yard, he found an increase of 1 ton .11 cwt. 47 lb. of turnips from the caked manure.*

3124. Oil-cake, independently as an article of food, or of manure, is an excellent medicine for live stock, preventing constipation of the bowels, and giving to the hide a *sweetness of coat* unattainable by other means. Mr Wilson of Edington Mains, in Berwickshire, tells me, that, ever since he has given oil-cake to his calves after being weaned in summer, they have not been affected with the usually fatal complaint of the quarter-ill; and he has experienced this beneficial effect for many years, without any external application of setons. By administering oil-cake to my cows after calving, I certainly prevented them being affected with the red-water, (2242.)

3125. I have already given the composition of linseed, (1262,) and of the ashes of linseed, (1263;) the quantity of linseed imported into this country to 1845, (1264;) the price of linseed oil, and of its proportion in the seed, (1323;) and of the composition of English and foreign linseed cake, as well as that of their ashes, (1268 and 1269.)

3126. Linseed and oil-cake are imported duty free, and since (1264) was written, the parliamentary returns give the importation of linseed in 1847 at 439,512 quarters, and in 1848, 796,013 quarters. In 1847, of oil-cake and rape-cake there were imported 61,978 tons, and in 1848, 73,029 tons, (1267.)

3127. The price of linseed in 1849 for sowing is from 43s. to 56s., and that for crushing from 42s. to 44s. the quarter.

3128. The Greeks preferred a very different period from ours for sowing the flax crop, their authorities saying that "flax likes places that are mry, but it is sown from the autumnal equinox to the day before the nones of January."[†]

3129. "Formerly the seed of the flax was occasionally used with corn to make bread, but it was considered hard of digestion, and hurtful to the stomach. In a scarcity of corn which happened in Zealand in the sixteenth century, the inhabitants of Middleburgh had recourse to linseed, which they made into cakes, and which caused the death of many of the citizens who ate of it, causing dreadful swellings of the body and face."[‡]

3130. The flax plant is stated to be a native of Britain, and yet it would appear that flax seed was not sown in England until as lately as A.D. 1533, when it was directed to be sown for the making of fishing-nets.§

ON THE SOWING, AND THE SUMMER TREATMENT OF HEMP.

3131. Hemp requires a deep rich mellow moist alluvial soil.

3132. Agreeing with manure, hemp may be cultivated as a green crop, but the quality of the fibre will be finer when the manure is applied to the soil in autumn upon the stubble, than immediately on the sowing of the crop in spring. Twenty tons of dung are required to the acre for the production of a good crop of hemp.

3133. The land should be cross-ploughed in spring, and harrowed and cleaned, and pulverised, as in the case with flax or potatoes, or any other such crop; but as the young hemp plant is very susceptible of frost, the land does not require to be prepared for the seed before the end of April, when the seed may be sown.

3134. There is no doubt, as the fibre should be both fine in quality and uniform in texture, that the hemp plant should be cultivated broadcast; but as it grows to the considerable height of 6 feet, and as certain processes of the cultivation require

* *Transactions of the Highland and Agricultural Society*, for July 1846, p. 376.

† *Owen's Geoponika*, vol. i. p. 87. ‡ *Phillips' History of Cultivated Vegetables*, vol. i. p. 208.

§ *Haydn's Dictionary of Dates*—art. *Flax*.

the work-people to be amongst the crop, the most convenient mode is to place the plant in rows; and as plants are placed most like the broadcast fashion when the rows are narrow, the best instrument for making such rows is the ribbing plough, fig. 230, or ribbing coulter, fig. 231, which make the rows from 9 to 14 inches asunder, according to the capability of the soil to produce a large or small plant.

3135. To secure a fibre of fine quality the plants require to be set close together; and for this purpose from $2\frac{1}{2}$ to 3 bushels of seed are required to the acre. The seed is large, of a flattened orbicular shape, greyish-brown colour, fresh aspect, somewhat oily lustre, and feels light in the hand. The seed should not be older than that of the preceding crop. Prove the seed by rubbing it between the hands, and if it suffers this without breaking, and becomes brighter, it is good. The bushel of seed weighs about 40 lb., and the seeds afford 200 to the drachm weight. The seed should be sown by hand along the ribs, or it may be sown broadcast over the ribs, and harrowed lightly along them with the grass-seed harrow, fig. 232, and the plant will come up in rows. The ground requires to be watched after sowing until the plants are in leaf, to keep off the birds of the finch tribe, which are very fond of eating hemp-seed, and even the young plants are injured by them—the capsules of the seed, being brought above ground by the embryo, are greedily devoured by those birds.

3136. The rows admit of the ground being easily kept free of weeds with the hand hoe or horse hoe in summer, but the hemp plants will soon grow up and overtop the weeds, which will be kept down ever after. Care should be taken in weeding not to break down the young plants, as they will never rise again.

3137. The hemp plant is not suited to the climate of Scotland. I have seen it cultivated there but once, and that in the farm of Kinnear in Fifeshire, when it was in the possession of the late Mr James Meldrum. It grew in a flat holm of small extent, and had attained the height of

about 6 feet, and was in bloom at the time. In England it is grown in many localities, but perhaps most successfully in Suffolk and Lincolnshire.

3138. Hemp would no doubt be benefited by a top-dressing of some manure, after it fairly assumed the form of a plant; and as pigeons' dung is considered by many cultivators as good manuring for hemp, guano, to the extent of 2 or 3 cwt. the acre, would perhaps be the best ingredient for the top-dressing.

3139. The hemp, *Cannabis sativa*, belongs to the class and order *Dioecia Pentandria* of Linnæus, which have the male and female flowers on different plants, and on which account it is unknown, when hemp-seed is sown, whether the plants produced will be male or female. In common parlance, the plant which bears the seed is called the male, whereas it is the female. Hemp is of the order *Urticææ* of the natural system of Jussieu, and is therefore closely allied to the common nettle; and it is of the *Didclinous Exogens*—alliance 19, *Urticales*—order 86, *Cannabinaeæ*—genus *Cannabis* of the natural system of Lindley. Stem upright, from 5 to 8 feet, strong and branching. Its valuable fibre makes the cordage of our ships. It is a native of the cooler parts of India, and is not cultivated there for its fibre, but for its intoxicating property. Dr Lindley says that "it appears to owe its narcotic properties to the presence of a resin which is not found in Europe. This resin exudes in India from the leaves, slender branches, and flowers; when collected into masses it is the *churris*, or *cherris*, of Nepal. Its odour is fragrant and narcotic, its taste slightly warm, bitterish, and acrid." The hemp plant of India is a legumen of the order *Fabacææ*, *Crotalaria juncea*, the sun hemp, which affords a coarse fibre, from which bags and low-priced canvass are largely prepared.

3140 "According to the observation of Vaucher of Geneva, the seeds of *Orabanche ramosa* will lie many years in the soil unless they come in contact with the roots of hemp, the plant upon which that species grows parasitically, when they immediately sprout. The manner in which the seeds of orabanche attach themselves to the plants on which they grow has been observed by Schlauter. This writer states that they only seize seedlings, and are unable to attack roots of stronger growth."

3141. An oil is expressed from the seed of hemp, which is "employed with great advantage in the lamp, and in coarse painting. They give a paste made of it to hogs and horses, to fatten them. It enters into the composition of black soap, the use of which is very common in the manufacture of stuffs and felts; and it is also

used for tanning nets.* The proportion of oil from the seed varies from 14 to 25 per cent.

3142. The price of hemp-seed in 1849 is for the small and the large from 34s. to 36s. the quarter. It is used for feeding birds, and those of the finch tribe are remarkably fond of it.

3143. The composition of hemp-seed, according to Bucholz, is as follows :—

Oil,	19.1
Husk, &c.,	33.3
Woody fibre and straw,	5.0
Sugar, &c.,	1.6
Mucilage,	9.0
Soluble albumen, (casein ?)	24.7
Fatty matter,	1.6
Loss,	0.7
	100.0

3144. The composition of the ash of the hemp-seed is this :—

Potash,	21.67
Soda,	0.66
Lime,	26.63
Magnesia,	1.00
Oxide of iron,	0.77
Phosphoric acid,	34.96
Sulphate of lime,	0.13
Chloride of sodium,	0.09
Silica,	14.04
	100.00
Percentage of ash,	5.60†

ON THE PLANTING, AND THE SUMMER CULTURE OF THE HOP.

3145. *Formation of a new hop ground.*—The soil for the hop should be deep and mellow, and if resting on a fissured rock, so much the better. An old garden, or an old meadow, forms the best site for a hop-ground. In every case the ground should be dry, that is, not subject to stagnant water, and, if not naturally dry, should be made so by thorough drainage.

3146. To afford sufficient room for the roots of the plants, the drain in a hop-ground should not be less than 4 feet deep, and the distances between the drains may be from 15 to 35 feet, according to the porousness of the subsoil. The expense may be stated at £6 the acre.

3147. The exposure of a hop-ground should not be directly to that of the meridian sun, because then the plants would

be subjected to the extreme temperatures prevailing every day; but it should rather be to the north on gently sloping ground, to receive a modified temperature, and to be away from the force of the prevailing S.W. winds. The sloping ground will also be favourable in evading the blights prevalent in the flat grounds of hollow valleys.

3148. The preparation of a new hop-ground, after its thorough drainage, should be the trenching of the soil to the depth of 2½ feet, which may be effected in this manner:—Let the ground be laid off in spaces of 15 feet in breadth to the length of the hop-ground. Let the surface mould to the depth of 15 inches, and 3 feet in breadth across the 15 feet space, be taken away with the common spade, fig. 237, to the opposite corner of the other side of the ground, to be ready to finish the trenching when it arrives at that point; and should a portion of the subsoil be required to be stirred, to make up the 15 inches of the surface so taken away, let it be so; and should the spade not be able to cut the subsoil, let the foot-pick, fig. 247, be employed to loosen it for the spade.

3149. The foot-pick, fig. 247, is a very efficient implement for stirring the subsoil, when in an indurated state. It stands 3 feet 9 inches in height. The shank is of iron, three-quarter inch square at the neck, under the eye through which the cross handle passes, and it is 1½ inch broad at the tramp. The tramp is movable, and may be shifted to either side of the shank to suit the working foot of the labourer, and it remains firm at 16 inches from the point, which inclines a little forward, to assist the lever power of the implement in loosening hard soil, or removing large stones. The cost of a foot-pick is 6s. 6d. The implement is used in this manner:—



THE FOOT-PICK.

* Wisset's *Treatise on Hemp*, which contains the sentiments of the best authorities on the cultivation of this plant.

† Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 381 and 921.

The workman raises it by the handle with both his hands, with the point bending away from him, and thrusts the point with force into the ground, and works it down with the pressure of his foot upon the tramp, until the instrument has penetrated as far as the tramp. He then pulls the handle towards him, and the shank acting as a lever upon the surface of the ground, as a fulcrum, the point raises the ground before it, or displaces any stone that may lie in its way. Should the ground be too hard to be affected by the power of the man's arms alone, he increases the power by pushing with successive impulses against the handle, upon which he sits, with the weight of the lower part of his body.

3150. Three men work best together when thus trenching hop-ground. All use the spade alike when the surface mould is of the requisite depth, and no picking is required; but when picking is needed, after a little of the surface has been removed, one man removes the surface, another picks the subsoil, and the third, generally the master workman, follows and shovels up the loose earth.

3151. After the surface has thus been removed, all the men take each a trenching-fork, such as fig. 248. This instrument consists of three connected prongs of iron, 15 inches in length, and $1\frac{1}{2}$ inch in depth at the neck, tapering to a

Fig. 248.



THE TRENCHING-FORK WITH THREE PRONGS.

stout point. The prongs are connected with a hose, into which a wooden helve, with a short cross handle, is fastened. The entire fork stands 3 feet 9 inches in height, and costs 5s. It is used by thrusting the prongs into the subsoil with the pressure of the foot, like the common spade; and using the helve as a lever, the workman forces the prongs through the substance of the subsoil, which is thereby ripped up into pieces, which are so far displaced, and deprived of all the stones of a larger size than the spaces between the prongs. Should the stones be very large, the

two-pronged fork, fig. 249, will remove them out of the ground with more ease to

Fig. 249.



THE TRENCHING-FORK WITH TWO PRONGS.

the men, and the subsoil be equally well subdivided and broken.

3152. When the bared space of 3 feet in breadth, 15 feet in length, and a spading in depth of 15 inches, has been fork-trenched by the 3 men, to the depth of the length of the prongs of 15 inches, the entire depth trenched will be 30 inches. The land is then manured thus:—Let a large dunghill of well-prepared and mixed farmyard dung be ready, near at hand to the hop-ground, and whenever each portion of the ground has thus been trenched, let some of the dung be put upon the trenched part with the graip, fig. 82, to the extent of 40 or 50 cubic yards to the acre. The dung is spread equally and trampled firmly down, not to be easily displaced.

3153. Then, upon the dung, let the surface soil of the next breadth of 3 feet be thrown to the depth again of 15 inches, by the same process as formerly described. The surface turf should be placed over the dung, with the grass face downwards, and the succeeding soil and subsoil mixed over the turf by chopping with the spade, and rendering the entire soil uniform and firm. Every large stone in the soil should be thrown aside for drains, or breaking into road metal. I have been the more particular in describing the fork-trenching, as well as that by the spade here, where first allusions to the subjects have been made, that the process may not again have to be described.

3154. In this manner let the entire hop-ground be spade and fork trenched, and manured below at 15 inches in depth: and such a mode of trenching and manuring has the advantage of removing all the large stones of the subsoil and soil, to the depth of the trench; of placing good manure 15 inches under the surface soil, to nourish the roots of the hop plants when they

reach it; and of maintaining the natural relation subsisting betwixt the soil and subsoil. The trenching should be finished by the end of autumn, at latest before the winter weather sets in; and in that state the soil may remain until spring, and derive all the meliorating effects of frost and rain.

3155. The cost of such a mode of trenching is considerable, but as the part trenched with the fork is done at less cost than by the spade, in proportion to the depth stirred, the depth of $2\frac{1}{2}$ feet will cost no more than about 20 inches with the common spade; because, in fork-trenching, the soil has not to be lifted up and turned over, but only stirred in its own place. The entire cost will, of course, depend on the quantity of stones to be removed, and the indurated nature of the soil and subsoil to be overcome; and, taking these at their worst state, the expense will not likely exceed £7 the acre, including the putting in the dung.

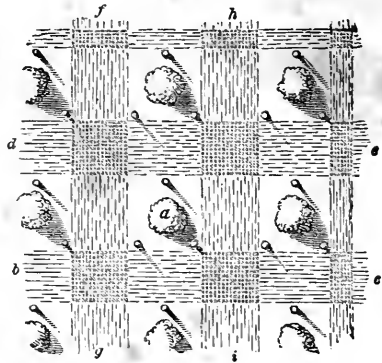
3156. To avoid such an expense, it has been recommended to plough and subsoil the ground simultaneously, the common plough going before and turning over the soil, or a skim-plough going before and turning over a thin furrow of the turf, fig. 240, followed by the common plough covering the turf with soil, and then the subsoil plough to stir the subsoil in the last plough furrow. This process may stir the soil to the depth of from 15 to 18 inches, but when done, however well, is inefficient compared with the thorough trenching described above; and although this may at first cost more than the combined ploughings, yet, in a case of establishing a hop-ground which has to remain perhaps for many years, the most substantial and the most satisfactory operation, and the most economical too, in the long run, is trenching by the spade and fork.

3157. Early in spring, in the end of March, the surface of the hop-ground should be harrowed and rolled, and reduced to as fine a tilth as practicable; and from 150 to 200 bushels of lime to the acre, according to the nature of the soil, should be applied to the surface and harrowed in.

3158. Everything is now prepared for

setting off the ground for the planting of the young plants. There are two methods of arranging the plants in a hop-ground—one in squares, and the other in quincunx; and of these two modes, the quincunx is the preferable, because the plants, standing independently, are more exposed to sun and air; a greater number of plants are placed on the same extent of ground, in the ratio of 120 to 100; and the ground can be cleaned nearer the plants with the horse-hoe. In fig. 250 is shown the square

Fig. 250.



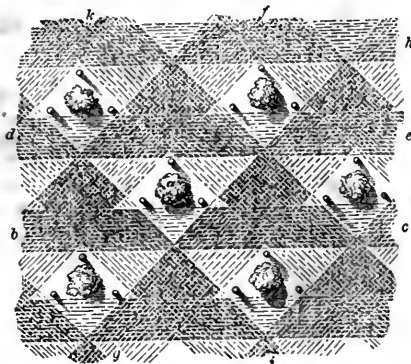
THE SQUARE METHOD OF PLANTING HOPS.

method, in which the hills of hops, such as *a*, are each surrounded, in a triangular form, by three poles. In cleaning the ground with the horse-hoe from *b* to *c*, one pole is closely passed at each hill on the right, and two poles are as closely passed on the left hand; and the same happens in cleaning the ground from *d* to *e*. On cleaning the ground in the direction at right angles to the former, as from *f* to *g* and *h* to *i*, one pole is passed closely on both hands at each hill. The intersecting lines *b c*, and *d e*, by *f g*, and *h i*, represent the spaces of ground stirred by the horse-hoe; and it will be observed that while a square piece of ground included by every four hills is stirred twice, a considerable space in the angles on each side of the single poles in the square piece of ground surrounding each hill is left untouched by the hoe, which must be cleaned by manual labour at an enhanced cost.

3159. In fig. 251 is shown the quincunx method, in which *a* is a hop hill, surrounded by three poles set in a triangular form, as in the square method; but

here it will be observed that in stirring the ground with the horse-hoe, from *b* to *c*, and from *d* to *e*, in one direction, and from *b* to *f*, and from *g* to *h* in another direction, and from *d* to *i*, and from *k* to *l* in a third direction, the ground is not only all stirred

Fig. 251.



THE QUINCUNX METHOD OF PLANTING HOPS.

close to each pole, which is as near the hop plants as any horse implement can approach them, but the greatest proportion of it is twice, and some of it thrice stirred. Of the two methods, therefore, the quincunx not only saves much manual labour in cleaning the land, but stirs it the oftener.

3160. The maximum distance between the plants is regulated by the combination of the power of the soil, and the nature of the variety to produce the largest development of plant; and the minimum distance is determined by the room required to keep the ground clean. In the former case, the distance should not exceed 7 feet; and for the latter purpose, it should not be less than $5\frac{1}{2}$ feet. Taking $6\frac{1}{2}$ feet as a good medium distance, the number of hills in the acre will be 1194 in the quincunx order, and 1031 in the square. The distances are set off by means of a measuring chain, and pins are stuck into the sites of the future plants.

3161. Young plants are produced in two ways, but both by cuttings from the prunings of the bines of the former year's growth, after the crop has been gathered from them. In the one case, the cuttings are inserted directly into the hills, where

they are to remain permanently; and in the other case, the sets are planted on a piece of ground for a year, to produce roots before being permanently inserted in the hills. With the *cut sets* is the risk of one or more of the plants dying in the hills before striking root, and, therefore, more are planted than are absolutely required; and should they all succeed in every hill, it becomes too crowded with plants. The number thus planted, is 5 in each hill. With *bedded sets*, as the others are termed, is little danger of loss; and therefore only 3 are planted in each hill. Of the two methods, I would always prefer the latter, although the other is most practised, merely, perhaps, because it saves the trouble of transplanting the young plants, and of having to provide a piece of ground for rooting the sets in. Bedded sets can no doubt be purchased; but some one, in that case, must take more trouble than will supply himself, in preparing the plants for others. Mr Lance mentions the raising of plants from seed, but when it is considered that no reliance can be placed on the varieties raised from seed, this does not seem an advisable plan, except for experiment to originate new varieties.*

3162. A hole is made in each hill where the pin was stuck in on setting off the ground; and before the plants are set into it, some rich compost, consisting of rotten dung, earth, and lime, is put into it, for encouraging the growth of the young roots, and to give them strength to strike down to the manure below. The rooted plants are set with their roots outwards, and their stems inclining a little inwards, in triangular order, and about six inches apart; and on the earth being pressed around them over the stems, a ring is made on the ground around each hill to mark its place.

3163. There are many varieties of hops cultivated, and some are greater favourites in one locality than others, being best suited to the soil, and also to other circumstances prevailing in the locality. Some of the best varieties are the Golding, the Canterbury, the Grape, Jones, and Colegates, names directly derived from individuals, places, and character of the pro-

* Lance's *Hop Farmer*, p. 53.

duce of the plant. Whichever kind is chosen, it is desirable to have only one variety within one hop-ground, or so separated as to be distinct from each other in the same ground, because the picking of the hops in the same piece of ground should take place at the same time, and different varieties require to be pulled at different times. And it is also desirable, in choosing different varieties, to have them to succeed one another in ripening, that too much work may not be thrown upon the workpeople at one time. Keeping these distinctions in view, it would seem that the Golding or Canterbury may be taken as one variety, the Grape as another, and the Colegate as the latest. Some of the Jones are recommended, as the broken and short poles answer to support them.

3164. Whatever varieties are chosen, as all sorts of hops are diœcious, it is necessary to have male plants amongst the female which bear the crop. Many hop farmers condemn the male hop as being useless; but experience has sufficiently proved, and common sense supports it, that when male plants are present to impregnate the female, the crop is always better and heavier. To secure their services, therefore, a hill of male plants should be planted at every 10 or 12 hills, which will give a proportion of one male hill to every 100 or 120 hop-growing hills. A few extra hills of males on the side of the ground whence the prevailing winds blow, will tend still more to secure the impregnation of the female flowers. The effect of the impregnation is not a matter of fancy, since the impregnated flowers are always larger, firmer, and heavier, and never grow so loose and open as the spurious ones.

3165. These are all the particulars requisite for the furnishing of a new hop-ground; and the expense per acre attending them is as follows:—

Draining,	£6	0	0
Spade and fork trenching,	7	0	0
Manure, 50 cubic yards, at 3s.,	7	10	0
Lime, 200 bushels, at 6d., and spreading,	5	0	0
Harrowing and rolling,	0	2	0
	<hr/>		
Carry forward,	£25	12	0

Brought forward,	£25	12	0
Setting off 1194 hills, at 6½ feet apart,	0	2	0
Planting 1194 hills of bedded sets, at 2s. 6d. per 100,	0	14	0
Compost for 1194 hills,	1	0	0
3582 bedded plants, at 6d. per 100,	0	17	0
Twisting the young bines, and re-pairing the hills in autumn,	0	15	0
	<hr/>		
	£29	0	0

One man at 3s., an assistant at 2s., and 2 boys at 6d. each, 1s.—in all 6s.—will set off 3 acres a-day: 2 men at 2s. each, 4s., and 1 boy at 6d.—in all 4s. 6d.—will plant 600 hills a-day.

3166. In the first year of a new hop-ground, the soil between the hills may be cropped with a green crop, manured for itself, in order to keep the ground clean, and cause it to make some return for the great outlay incurred in converting it into a hop-ground.

3167. During the summer, the young plants will put out bines, which must be supported by inserting beside them an old pole or stob, and fastening them to it. When bedded sets have been employed, a small crop of hops may be expected.

3168. In autumn, after the bines have died down, they should be cut off, and a small mound of earth put over them, to remain all the winter. Some leave the bines on until after the ground is dug in spring, but the mounding the young roots preserves them safe all winter against frost.

3169. *Digging*.—As regards the treatment of the growing plants of a hop-ground, the soil is dug over in spring, as early as its state will permit in March; and this is done with a three-pronged tool named a *hop-spud*, having the forks or *speens* broad and flat, or with a square *speen* which turns over the several pieces of the soil raised at each stroke. An experienced hand, with either of these implements, will turn over the ground more easily for himself than with the common spade, which obliges him to lift as well as turn it over. Digging costs from 18s. to 20s. the acre.

3170. *Manuring*.—The annual produce of a hop-ground, consisting of the hops and bines, being very considerable, and as

the perennial nature of the plant does not permit it to be placed in the category of those plants of the farm which follow each other in any given rotation, it is necessary to manure the ground every year at least once, if not twice. The first manuring after the crop may be given in the autumn or in spring, and if in the latter, the time to do it is before the digging of the ground commences. The best plan is to apply the manure twice a-year—in the spring, with farm-yard manure and rags, and during the summer with some assistant, as guano, rape-cake dust. Of farm-yard dung, from 25 to 30 cubic yards should be given to the acre. Black mould is an excellent application about the crown of the roots, and from 80 to 100 single horse-loads should be put on the acre. The dung and mould may be carted on the ground, if its state permit; but the manure applied and dug in in summer should be wheeled on to the land, and the operation will cost about 1s. per 100 hills. Woollen rags cost £6 per ton, and from 12 to 20 cwt. per acre will be required. Woollen waste or shoddy may be had for £4 per ton, and from 20 to 30 cwt. per acre will be required.

3171. Guano and rape-cake dust are convenient applications, in June and July, to be made around the plants and spread over the surface and hoed in with horse-labour in damp weather. About £4 of cost of either, to the acre, will suffice for one manuring. Some seem to doubt that the summer manuring does any good, but experience has proved, by comparative experiment, that the yield of crop is considerably increased by it.

3172. *Dressing the shoots.*—After the manuring and digging in spring, the shoots of the hops are dressed, and cuttings made from them. These are nice operations, and require an experienced hand to execute them, otherwise the success of the future will be rendered doubtful. A recent author, Mr Rutley, writes thus particularly on this subject. After stating that a boy or woman opens around the stock of the hill, with a small narrow hoe, a little below the crown of the hill, “a man follows with a pruning-knife and a small hand hoe, with which he clears out the earth on the crown of the hill between

the sets or shoots of last year that were tied to the poles; and which, from having earth put on them the preceding summer, swell out to four or five times their original size, and form what we call sets or cuttings; and it is the cutting them off at the right part that should be particularly attended to, or great injury may be done. It is therefore necessary that the person cutting them should ascertain exactly where the crown of the hill is, that he may not cut them too low or too high; and the place where they should be cut off is between the crown of the hill and the first joint, for it is around the set close to the crown where the best and most fruitful bine comes. If the set is pared off down too close to the stock or crown, it takes away the part from where that bine comes, as little buds are seen ready to shoot forth at the time of cutting, which, if cut off, the bines come weakly and few. On the other hand, if the set is cut off above the first joint, which sometimes will be the case, if the man in cutting does not pay the attention to it he ought, the bines which come from that or any other joint higher up the set grow fast, but are coarse, hollow, or what we call pipey, and unproductive: all such should be discarded at the time of tying. Consequently the operation of cutting or dressing, on which the future well-doing of the plant so much depends, is not left so much to the judgment or skill of the operator as to his care and attention. Many planters have their hops dressed by the day, paying extra wages to persons in whom they can confide to do it with care. After all the old bine and runners, as the roots and small rootlets near the surface are called, are cut and trimmed off clean; some fine earth is pulled over the crown, and a circle made round with the hand-picker, to intimate where the hill is before the young shoots appear.” The male hills are particularly marked. The dressing should be finished before the end of March. It costs 6d. per 100 hills.

3173. Such of the sets as have two or more joints are selected to make a new hop-ground with, or sold for that purpose; but the cuttings should only be taken from the most healthy bines.

3174. *Poling.*—Everything is now ready

for the reception of the poles—for, the hop being a climbing plant, it is necessary that they be supplied with poles sufficiently strong and long to support them effectually. The best poles are of yew, next of chestnut, then larch, ash, willow, oak cut in winter, Scots fir, birch, alder, beech, in the order enumerated. As three poles are required for each hill, every acre of hop-ground requires 3600 poles. They cost 1s. per foot the 100 poles—that is, poles of 20 feet in length cost 20s. the 100, or £36 the acre. They last from 3 to 5 years, according to the wood they are made of; and thus, at the longest, 700 poles per acre are required to maintain the stock of poles in an efficient manner.

3175. To lessen this great expense, it has been suggested to employ stout wire to support the bines between a few strong poles; and I have no doubt, now that wire is extensively employed in field fencing, that it might be as usefully employed in hop-grounds. The bines could be spread and tied with freedom on such wires, for exposure to sun and air, and the tyings could be effected with great ease and precision.

3176. The poles, when about to be set, are chosen in conformity to the variety of the hop they are intended to support; for if long poles are set beside a low-growing hop, the plant will be drawn too much up and prove unproductive; and, on the other hand, if the poles are too short for the plants, the tops of the plants will bend down and not branch out, and the crop will be smothered. Much, however, must be left to chance in this matter, as a favourable season for vegetation will cause a short variety of hop to grow tall, and a stinting year will prevent the tallest attaining their proper height. The poles are new sharpened at the ends every year; and, when sharpening them, trial should be made of each pole, whether it be strong enough above the sharpened point to bear a slight blow, and if it cannot, it would have broken off in high wind, and caused much inconvenience and loss. Whenever a pole proves doubtful, it should be cut short and sharpened, to be used by a lower class of plants, or by the young plants in a new hop-ground.

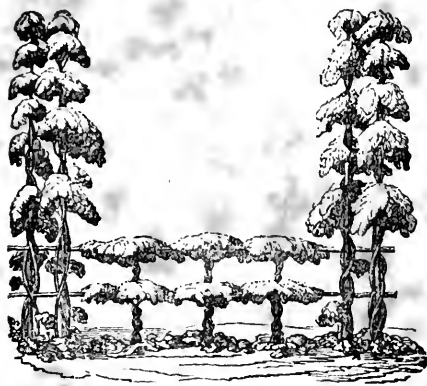
3177. Three poles are set around each

hill, as shown in figs. 250 and 251: they are set from 18 inches to 2 feet apart, according to the strength of the plants to be supported. An instrument like the fold-pitcher, fig. 63, makes a hole deep enough to give the end of the pole a firm hold of the ground, which should be as many inches in depth as the pole is of height in feet. The pole is pushed down to the very bottom of the hole, and if it have any crook or set at the lower end, it is placed inwards to be out of the way of the horse in cleaning the ground; and the top should have a lean outwards, to give room to the bines to branch; while the body of the pole should be as upright as possible, in order to give it the strongest position. The cost of poling and sharpening is from 1s. to 1s. 6d. per 100 hills of three poles, according to the size of the poles and the nature of the ground; and the carrying of new poles into the ground costs from 1d. to 3d. per 100 poles.

3178. Many modes have been devised of setting the poles. A mode adapted by Mr Knowles, in Kent, seems to combine the advantages of affording shelter to the hop-ground, and of training the bines for the greatest production. The weather side of the ground is poled four hills deep, with 21-foot poles in rows from end to end. To these are lashed similar poles, placed horizontally from pole to pole about eight feet above the ground; and each row of such lashed poles is bound to the nearest one, by means of horizontal poles similarly lashed and placed at right angles to them from the outside to the inside rows. By these means a phalanx of poles offers a sufficient resistance to the wind, and shelters the whole ground; and this plan has proved a means of increasing the quantity of hops grown on the outside row, which is covered with from 13 to 14 feet of hops from the top, and branched and clustered most heavily on the cross poles, thereby showing the advantage of keeping the tops of the plants firmly fixed, instead of allowing them to swing about in the wind. The increased expense of poling a ground in this way is 30s. the acre, besides an extra hand at the poling; but the saving in a windy season is considerable, both in hops and poles.

3179. The best hops grown at Lewis-ham have been trained horizontally in the espalier form, as represented in fig. 252, on poles 5 feet high, and 3 feet apart, with

Fig. 252.



ESPALIER FORM OF TRAINING HOPS.

a long pole or two at such intervals as may be desired, fixed to the top of the horizontal ones to keep them steady. A plant is set at each stake, and the rows are formed one way across the field. This method may be adopted with success where poles are scarce, and where the ground is exposed to winds. All the male plants should be placed on the long poles, that their farina may drop on the female flowers on the lower ones.

3180. Immediately after the poles are set, the ground is horse-hoed as deeply as possible, and all weeds making their appearance eradicated; and this operation is conducted through the summer, as opportunity offers. Some object to the employment of horse labour in a hop-ground, but it is cheaper than hand labour, and equally effectual.

3181. Whenever the bines shoot to a length to be fastened, they are tied to the poles. Three of the best bines are selected to be tied to each pole, and the rest are cut away. The bines are tied by women—a woman and her family, or by single women—and the job is taken by the piece at 8s. the acre. The ties are made with withered rushes, which cannot injure the stems of the bines against the poles; and the tie is made with a slip-knot, so that the tying may give way as the bines enlarge in diameter. The tyings are done from near the ground up to 5 feet above it,

and when above that height ladders are used, which stand independently upon the ground. The tying begins about the end of April.

3182. From 18 inches to 2 feet of the lower end of the bines should be stripped of their leaves, to allow air to get to the crown of the roots, and to dig about the hills during the summer. Some hop-farmers cut off the branches of their bines for a considerable height above the ground, which seems an unnecessary practice in any case, and in the case of those hops which shoot out bines near the ground it must be positively injurious. The stripping costs 2s. the acre. In some seasons, as of wind, the young bines are apt to lose their head, or leading shoot, in which case one or more lateral branches will have to be removed, to allow one to take the lead, and this one should be carefully trained to the pole. In every season some of the poles will be blown down by the wind, and in such cases the common practice is to tie the bines to an adjoining pole; but a better plan is to sharpen the bottom of the broken pole and push it into the ground again, and although shorter than it should be, it will keep the bines in a better state of preservation for ripening the crop than when tied to another plant, to the injury of both plants. The repairing of blown-down poles will cost about 5s. an acre.

3183. After the bines have all been tied up, and the leaves stripped below, which will be about the first or second week of June, the ground around the hills where the horse-hoe could not touch should be dug over with the spade or *spud*, and will cost from 3s. to 8s. the acre. This digging is necessary for the double purpose of loosening the earth about the crown, and the hills, trodden down by the tiers. If the ground is rough in the alleys, it should be harrowed, and even rolled, to render the tilth as fine as possible. Besides these operations, earth is placed upon the places where the bines had been cut off, and this is requisite to stop the fresh shoots rising up from the stools—to keep the weeds under—to support both the bines and the poles—and to strengthen the shoots that will be the cuttings and the bines of next year. Earthing is done to the end of June, and costs 3d. the 100 hills. This finishes

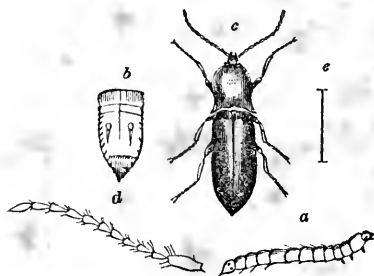
the summer treatment of the hop in as far as the manual labour is concerned, but the horse-hoe must be used until the crop becomes ripe, in order to preserve the ground in a loose state for the roots of the plants, and to overcome surface weeds.*

3184. The hop-plant is subject to the attacks of insects and other maladies in the course of its growth. Amongst its earliest enemies is the *Wire-worm*. This insect is the larvæ of a tribe named Elateridæ, or click-beetles, which are readily known by having the sternum produced behind a strong spine, fitted to enter a groove in the abdomen, situated between the intermediate pair of legs, as thus described by the Rev. Mr Duncan: "By bringing these parts suddenly into contact," he observes, "the insect is enabled to spring to some height in the air, and thus recovers its natural position, when it happens to fall on its back, which it frequently does when dropping from plants to the ground. A special provision of this kind is rendered necessary, in consequence of the shortness and weakness of its legs. Upwards of 60 different species of wire-worms occur in Britain, and it is probable that a considerable proportion of them feed upon our most valuable cultivated plants. The same species of larvæ does not appear to confine itself to one kind of food, but attacks indiscriminately the roots of corn and other grasses, as well as esculent roots, such as turnips, carrots, radishes, &c. But it is at the same time deserving of notice, that, as a strong similarity prevails among larvæ specifically distinct, it is probable that different kinds may often have been confounded, and a more correct knowledge may prove them to be more restricted in their choice of food than is at present supposed: this at least is rendered not unlikely by what is observed in analogous cases. We are as yet acquainted with the metamorphoses and habits of a very small number of these insects; and it is therefore highly desirable that, wherever a destructive wire-worm prevails, it should be traced to the perfect condition. This, however, is attended with considerable difficulty, owing to the length of time they continue in the larvæ state, extending in many instances to several years. But we

are fortunately enabled to furnish a pretty complete account of one of the most common kinds; and as the family is a very natural one, we may thence derive a pretty correct notion of the natural history of the whole. Any mode of treatment which checks the depredations of this species will probably be equally effectual in regard to the others.

3185. "The character of wire-worms generally is, that they have a long, slender, and cylindrical body, covered by a tough crust, which has occasioned the above name. They are composed of 12 segments, fitting closely to each other, and are provided with 6 conical scaly feet, placed in pairs on the three segments next the head. The latter is furnished with short antennæ, palpi, and two strong mandibles or jaws. The species alluded to as being well-known is the larva of *Cataphagus lineatus*. When full-grown it is about seven lines long, a line being the twelfth part of an inch, and rather less than a line in breadth, as *a*, fig. 253. The shape of the body

Fig. 253.

THE WIRE-WORM AND ITS PERFECT BEETLE—
CATAPHAGUS LINEATUS.

would be perfectly cylindrical were the back not a little depressed. It is entirely of an ochre yellow colour, except the anterior part of the head, which is brown: for some time after a change of skin, it is white. Owing to the rigid consistency of the skin or crust, the larva can scarcely contract its body, but, being composed of rings or segments, it is flexible enough from side to side. These rings are 12 in number, the three nearest the head each provided with a pair of conical legs, and the caudal segment having a fleshy tubercle

* *Journal of the English Agricultural Society*, vol. ix. p. 532-563.

beneath, which serves the purpose of a seventh foot. The last-named is conical, terminating in a point, and is remarkable for having two circular holes, like two brown points in the surface, as in *b*. It is difficult to conjecture the use of these, unless they be a kind of stigmata which serve for respiration; but the real stigmata are placed along each side, appearing like small brown points from the fourth to the eleventh segment inclusively. The whole body is smooth, with a few scattered hairs. The pupa into which the larva changes, is nearly white, with two black points over the eyes; the length about three lines. The front has two brown projecting points, and the abdomen consists of 10 rings, the last of which terminates in two short spines. The perfect insect *c*, which issues from the pupa, is of a brown colour, thickly covered with short pubescence. The antennæ *d* are about the length of the head and thorax, with the radical joint long and thick. The under side of the body is dusky and pubescent; the legs obscure yellow: length *e* about four lines, breadth $1\frac{1}{4}$. This insect occurs in considerable plenty throughout the country, in green fields and pasture lands, and is usually found creeping among the herbage, or lying at the sides of stones; it is scarcely ever observed on the wing.

3186. "Another species, at least what is usually regarded as such, occurs in similar places, and generally in much greater abundance, at least in Scotland, namely *Cataphagus obscurus*. This insect is so closely allied to that above described that it may readily be taken for a variety of it; and there is little doubt that the description of the larva of *C. lineatus*, will apply almost equally to that of *C. obscurus*. From the great abundance of the latter, it may be presumed to be the species which commits most injury in this country.

3187. "There is another species, which occurs more plentifully in ploughed lands throughout the south of Scotland, but which we have never heard charged with similar depredations. Yet there is no doubt that the larva is a root worm, and, from the places the perfect insect frequents,

it is likely to feed on the cereal and other useful grains. This is the *Hypnoidus riparius*, a small insect of a brassy-black colour, with pale reddish legs."*

3188. Fortunately, the wire-worms find numerous enemies amongst the same class of creation of which they form a part. "Concealed, therefore, as the wire-worms are in the earth," observes Mr Curtis, "and armed with a coat of mail which will withstand most external assaults, a little ichneumon-fly, probably a *Microgaster*, discovers their retreats, and puncturing the sutures of the skin, in all probability which are the more membranous, deposits her eggs in the body of the worm, to feed upon the muscles, and thus destroy this enemy to the cultivator." That shining black beetle which inhabits wet and damp localities, *Steropus madidus*, destroys the wire-worm with its mandibles. The small tick, *Uropoda umbilica*, infects the perfect beetle of the *Cataphagus obscurus*; and the brilliant scarlet-coloured harvest-bug, *Leptus phalangii*, already referred to in (2956,) as the *Acarus autumnalis* of Shaw, infests another species of wire-worm beetle, *Elatер ruficaudis*.†

3189. I have been the more particular in giving a detailed description of the wire-worm, as many insects, such as centipedes, which inhabit the ground and injure the crops are so called; and a remarkable instance of such a mistake has been committed by Mr Lance, in assuming the wire-worm to be a scolopendra.‡

3190. As a trap to catch wire-worms, potatoes cut in two, and turnips sliced, may be buried around the hills, and examined daily and replaced, by which means many may be destroyed, as the insects will leave the roots of the hop to regale on these esculents.

3191. Other insects, besides the wire-worm, injure the hop. The caterpillars of the ghost-moth, *Hepialus humuli*, which are of a rather glossy cream colour, with the head brown, and a scaly patch on the neck, feed on the root of the hop, and it changes in May to a dark-brown pupa;

* *Quarterly Journal of Agriculture*, vol. viii. p. 101-3.

† *Journal of the English Agricultural Society*, vol. v. p. 209-227.

‡ *Lance's Hop Farmer*, p. 73.

but this insect is more common in grassy places in June, and not unfrequent in churchyards, and hence its name.* A flea-beetle, not unlike the turnip-beetle, commences its attacks upon the young leaves and heads of the hop as soon as they appear, stopping their growth, and even quite destroying them. When the shoots attain six inches or more, the insects may be brushed off into any receptacle held to receive them. A more formidable foe is the hop aphid, which commences its attacks after the flea-beetle has ceased, about the latter end of May, when the vines have reached four or six feet up the poles, on the under side of the small leaves near the head of the bine. The attack of the plant-louse is called a blight, though that is another disease occasioned by the growth of a parasitic fungus. The hop in some seasons recovers from the attack of the aphid, as in 1807, 1834, and 1846; but in others it is almost entirely destroyed, as in 1837; while it is remarked that the same ground is not attacked in two successive seasons. The natural enemy of the aphid, *Aphis humuli*, is the larva of the lady-bird, *Coccinella bipunctata*, and one or more of the ichneumon-flies, which deposit an egg within the body of the aphid, the larva from which destroys the enemy.

3192. Besides by insects, the hop is assailed by a parasitic fungus, common called the mould, because the plants seem moulded. It is most subject to this disease in moist warm summers, and its effects are most disastrous, as it deprives the plant of the power of forming the flower; but it is partial in its attacks, confining itself to certain spots and localities.

3193. The power of some hop-grounds to produce a great crop every year, when external circumstances do not occur to prevent it, is extraordinary. Many grounds have borne crops for upwards of half a century, and some exceed in age an entire century. It must not be supposed, however, from this, that any plant that was planted at the formation of the ground remains alive such a length of time. Whenever a plant or an entire hill indicates symptoms of decay, it should be removed, and another substituted; but care should be

taken to plant the same kind of hop as that cultivated in the ground. In Flanders, the hop-ground is not cultivated above five years, when it is rooted up, and the soil cultivated with ordinary crops.

3194. The hop, *Humulus lupulus*, belongs to the same place in the system of plants as the last-described plant, the hemp, that is the class and order *Diaceæ Pentandria* of Linnæus, some plants having male flowers and others female flowers; to the natural order *Urticaceæ* of Jussieu; and to the *Declinous Exogens*—alliance 19, *Urticales*—order 36, *Cannabinaeæ*—and genus *Humulus*, of the natural system of Lindley.

3195. "The bine and leaves of hops have been used for tanning light skins," as Mr Lance informs us, "instead of oak bark, and a patent has been taken out for the process by Mr J. P. Newman, London.

3196. "In Sweden the stalks of hops are successfully converted into strong cloth for sacking and coarse bags for hops, for which purpose the stalks are gathered in autumn, soaked in water during the winter, and in the succeeding spring, after being dried on stoves, are dressed like flax.

3197. "A coarse sort of brown paper has been made from the vines of the hop, at a mill in the neighbourhood of Maidstone.

3198. "Hop vines are also used as binders for the sheaves of corn and bean haulms.

3199. "The prunings are also cut into pieces and stacked for winter provender for cattle and horses, which are fond of them, their bitterness constituting an excellent stomachic. The vines require careful harvesting to preserve them."

3200. The tender shoots of the hop in spring may be used as a pleasant bitter salad; and "in Flanders, where the hop is cultivated, the principal culture being from Brussels to Alost, they use the young shoots in the same way as asparagus, tied in bunches, boiled and stewed, and eaten with butter and gravy. Such bunches are sold in the vegetable markets.

3201. "From the young leaves and offshoots of the bine, after being dried, an extract is obtained, which will dye woollens of a fine cinnamon brown. The expressed juice of the bine is well known amongst French chemists, as affording a permanent red-brown colour."†

3202. According to the analysis of Mr Nesbit, 9½ oz. of the Golding hop leaves, dried at steam heat, lost 1¼ oz. of moisture, and left 8¼ oz. of dried leaves. The dried leaves, burned to ashes, gave 572 grains, being at the rate of 16½ per cent. Of the yellow grape hop leaves, 14¼ oz. lost of moisture in drying 1⅞ oz., and left 12 oz.

* Stephens' *Illustrations of British Entomology*, vol. i. p. 6.

† Lance's *Hop Farmer*, p. 17.

of dried leaves. The dried leaves, burned to ashes, gave 25 per cent of mineral matter. The composition of the ashes was as follows:—

	Golding Hop leaves.	Yellow Grape Hop leaves.
Potash,	12.48	5.13
Soda,	0.32	2.29
Lime,	41.46	32.28
Magnesia,	1.99	6.24
Sulphuric acid,	4.20	3.63
Phosphoric acid,	2.02	3.68
Phosphate of iron,	2.93	0.54
Carbonic acid,	16.54	21.25
Chloride of sodium (common salt,)	7.92	4.58
Silica,	10.14	20.38
	<hr/> 100.00	<hr/> 100.00

3203. Of the *Golding hop bine*, 1 lb. 2½ oz. dried at a steam heat, lost 1½ oz. of moisture, and left 1 lb. ¼ oz. of dry bine. The dry bine burned, gave 353 grains of ashes, being at the rate of nearly 5 per cent. Of the *yellow grape hop*, 2 lb. 12 oz. of bine, dried, lost 4¾ oz. of moisture, leaving 2 lbs. 7¾ oz. of dry bine. The dry bine, in being burnt, gave 5.1 per cent of mineral matter. The composition of the ashes was as follows:—

	Golding Hop bine.	Yellow Grape Hop bine.
Potash,	18.62	12.97
Soda, . . . . .	...	2.32
Lime,	29.59	17.39
Magnesia,	3.15	12.61
Sulphuric acid,	2.63	3.14
Phosphoric acid,	5.22	3.14
Phosphate of iron,	0.31	2.06
Phosphate of alumina, . . . . .	...	1.55
Carbonic acid,	23.51	24.18
Manganese, . . . . .	...	a trace.
Chloride of sodium (common salt,)	4.95	9.98
Chloride of potassium,	7.38	...
Silica,	4.64	5.66
	<hr/> 100.00	<hr/> 100.00*

ON THE SOWING, AND THE SUMMER CULTURE OF THE TURNIP.

3204. I shall now take for subject the culture of the turnip, because it is the most important root-crop cultivated, and whatever relates to it may easily be applied to the culture of every other of the root-crops cultivated on the farm, such as *kohl-rabi*, *mangold-wurzel*, carrot, and the like, although one or all of these may be sown earlier than the turnip. The turnip occupying the same place in the order of crops as the potato, the land is prepared for it in precisely the same manner as has

been described for that crop from (2732) to (2736.) Having drilled up as much land as will allow the dunging to proceed without interruption, that process is carried on as described in (2749 and 2750); and then the ploughs proceed as in (2752.) This mode of dunging is the same as recommended for drilled beans, (2433,) and more fully described for potatoes. The only difference between preparing the land for turnips and potatoes is, that, as turnips are later in being sown, more time is found for cleaning the land thoroughly for them, on which account another ploughing or another grubbing, according to the circumstances of the weather, may be given to the land before the process of dunging is commenced.

3205. When the land is to be manured with farm-yard dung, it is first drilled in the single mode, (2389,) as being the best and most expeditious; but as the drills for turnips must be formed of exactly the same distance, to accommodate the working of the drill-machine for sowing the seed, the best ploughman should be desired to form those drills.

3206. When farm-yard dung is alone used for manuring the turnip crop, the quantity applied generally differs from 12 to 15 tons the acre, according to the sort of turnip—the Swedish variety receiving the larger quantity, and the white the smaller. In the neighbourhood of towns, much more manure is applied to the turnip crop—as much as 32 loads of at least 15 cwt. each of town manure the acre, and upwards of 20 tons of farmyard dung. The more dung the turnip receives it will yield the heavier and more valuable crop; still, if the farmer depend entirely on the sources of the farm for manure, he cannot apply a large quantity to one crop, without depriving others of their share. After the dung has been ploughed in by the double mode of drilling, (2397,) the land is ready for the seed.

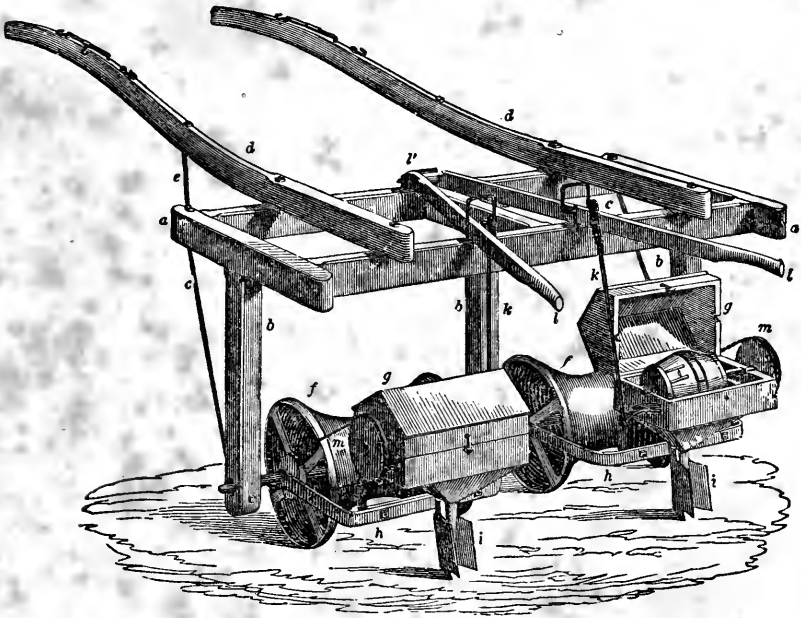
3207. Of the varieties of turnips usually cultivated on the farm, I have already given a sufficient account, from (843) to (854.) The Swedish turnip should be sown about the 15th May, and 3 lb. of

seed to the acre will suffice. The seed varies in price from 9d. to 1s. a pound, according to the supply. The next hardy turnip, the yellow, should be sown immediately after the swedes are finished with a smaller quantity of seed, $2\frac{1}{2}$ lb. to the acre—the seed being smaller, more of course are found in the same measure. The white turnips may be sown any time from the beginning to the end of June, and in England they are seldom sown before July, for, if sown too early, according to the climate, they are apt to run to seed. The price of the yellow and white

turnip seed is the same, 9d. the pound, and the quantity sown of both may be the same. A little saving in turnip seed is of no great importance, unless when one farms on a very large scale; and if fresh seed only were used, much smaller quantities than those specified would suffice.

3208. *Two-rowed Turnip-drills.*— Turnip seed is always sown with a drill-machine, and one of the most efficient and simple sowing drills which sows seed alone is the East Lothian turnip-drill. Fig. 254 is a view in perspective of this drill;

Fig. 254.



THE EAST-LOTHIAN TURNIP-SOWING DRILL.

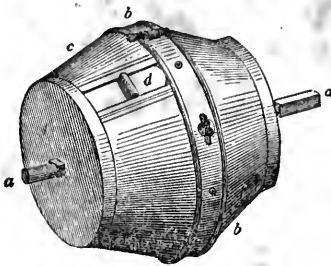
in which *aa* is the bed-frame, consisting of two transverse and three longitudinal bars, to which are mortised three upright bars *bbb*. Stay-braces *cc* are attached to the bed-frame by bolts, though in many of the inferior machines these are omitted, greatly to the deterioration of their strength and durability. The horse shafts *dd* are bolted to the transverse bars, supported by stay-braces *e*, and furnished with the usual horse mounting. This machine sows two drills at a time, and, to support it upon two of the drills of land, two rollers *ff*, which are both motive and compressing, are provided one for each drill, and so curved longitudinally as to

embrace the upper part of the drills, and revolve upon a shaft passing through the lower ends of the upright bars *b*. Of the two seed-boxes *gg*, one is shown thrown open, and they are attached to the iron bows *hh*, through the ends of which the axle also passes, whereby the whole becomes movable upon the axle. The bottom of the boxes is formed funnel-shaped, terminating in a nozzle which passes between the sheathes *ii* of the coulter for conveying the seed from the boxes to the ground: the bottoms of the boxes are firmly attached to the bow *h*. Connecting rods *kk* are attached to the seed-box frame, for regulating the depth of the

coulter in the soil. The seed-barrels are mounted on axles within the box frame *g*, the outer extremity of which is furnished with a pulley *m*, corresponding to another fixed in the end of the roller *f*, and both made to move by means of a jack-chain. The handles *ll* move upon the joint *l'*, and when elevated draw the coulters *ii* out of the ground, and when depressed by the weight of the hand, keep them steady in the ground. An important function of this machine is its self-adjustment to the width of the drills. This is accomplished by the width between the pendants *bb* being greater than the length of the rollers, together with their attached pulleys and iron bows *k*, which admit of a ready lateral motion of the rollers, with their accompaniments of bow, coulters, and seed-boxes, so soon as the machine is put in progressive motion, and the curved rollers feel any unequal resistance right or left. Any such unequal resistance, on either end of the rollers, draws it immediately to that side where the resistance is felt, until it is fairly adjusted to the slope of the drill; the effect in this case being produced entirely by the action of the sloping sides of the drill against the conoidal sides of the rollers.

3209. Fig. 255 is a perspective view of the seed-barrel, detached from its seat;

Fig. 255.



THE SEED-BARREL.

aa is the axle or spindle in which it revolves, and on the longer end of which the pulley is placed. The barrel is formed of tin-plate, in two conical frusta, joined base to base, with a cylindrical band *b* interposed between the two, and the truncated ends are closed with discs of hard wood. The band *b* is usually divided into six equal parts, and at each point of division three small apertures

are punched out, each three varying in size from a sixteenth to an eighth of an inch diameter, but all in the same order from more to less. A separate band is then fitted to the first, closed with a clasp-joint, and capable of being slid round, to a small extent, upon the interior band, and is, besides, provided with a pinching-screw, by which it can be fixed at any point within its range of motion, which does not necessarily exceed one inch. The movable band is likewise divided into six equal parts, and at each division a perforation is made larger than any of those in the interior. By these arrangements the movable band can be placed so as to expose any of the three sets of the six perforations of the inner band, whereby a greater or lesser quantity of seed can be sown according to circumstances. In the figure, the perforations are seen on the outer band; the clasp-joint also is seen near the upper side *b* of the figure; and the pinching-screw and slit, by which it can be fixed or moved, are seen in the middle of the figure. The slider *d* covers a hole by which the barrel can be filled or emptied of seed.

3210. This machine is furnished with a pair of small covering rollers, made of any hard wood, mounted in light iron frames or shears, which are hooked on to a bolt in the coulter-frame, and are thus dragged behind the machine. These rollers are not considered as forming an essential part of this drill, though they serve to compress light soils from drought, but on heavy soils a crust would be formed on the surface, should rain fall afterwards. The figure given here is from the machines as manufactured by Mr James Slight, Edinburgh. The price of this drill, in the ordinary state for sowing seed alone, ranges from £5 to £6, 10s.

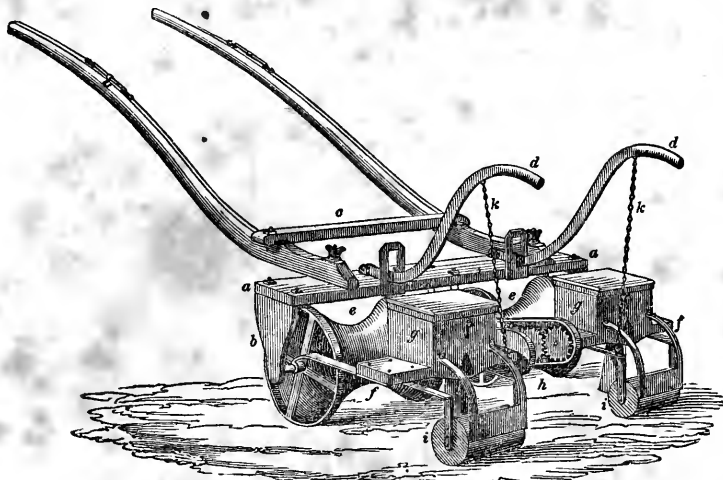
3211. Several varieties of this drill are to be met with, in which the chief difference lies in the mode of communicating motion to the seed-barrel, and of throwing it out of gear. This last particular may be regarded as a defect in the machine just described, and undoubtedly it is a defect; but the question is simply whether it is more economical to lose a half or one per cent of seed every year, or pay a considerable addition in price to the original cost of the machine, which the adoption of the disen-

gaging principle would incur. For my part, I am so fond of having everything in the best state it can be obtained, that I would willingly pay the additional cost

rather than want the power of stopping the issue of the seed when desired.

3212. Fig. 256 gives a view in perspec-

Fig. 256.



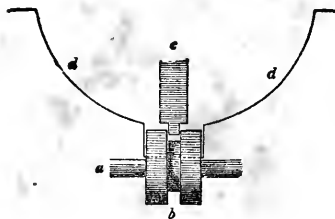
GEDDES' TWO-ROWED TURNIP-SOWING DRILL.

tive of a variety of turnip-drill, contrived by Mr Geddes, Cargen Bridge, Dumfriesshire. Its construction of parts is much the same as that already described, but the depression of the parts forming the framework gives the machine an appearance of compactness and strength. The bed-frame *a a* is a plank, *b* are the pendants upon which the frame-work is supported upon the axles of the curved rollers *e e*. The horse shafts *c* are bolted on the plank *a*, and the handles *d d* are jointed to it, and, being embraced by open guards, permit the elevation and depression of the coulters by means of the chains *k k*, according to circumstances: *g g* are the seed-box frames; *h* are spur-gearing, shown exposed, by which the seed axles are moved; and *i i* are the hind covering wheels.

3213. The distributing apparatus in this machine is peculiar, and has been considered to contain its principal merit, and supposed to afford a more correct means of graduating the quantity to be sown than the common seed-barrel, fig. 255. This apparatus is very simple; the interior of the seed-box is formed into a semi-cylinder, which may be of wood or of tin-plate.

Fig. 257 is a transverse section of this, *d d* being the interior surface of the box,

Fig. 257.



THE VERTICAL SECTION OF THE SEED-DISTRIBUTOR.

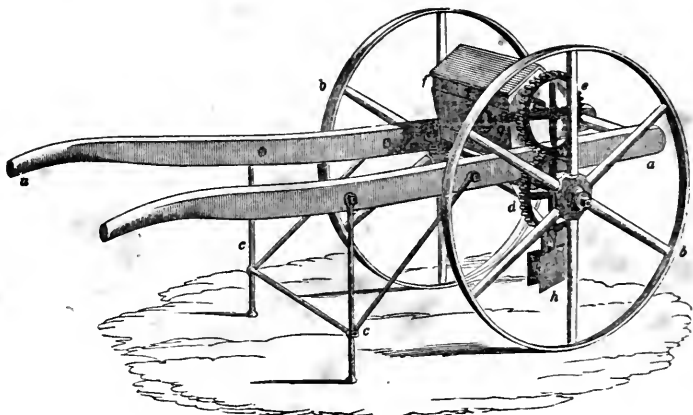
in the bottom of which an opening is made to receive a brass roller *b*, having a groove running round it. The roller is mounted on an axle *a* which is prolonged to a sufficient distance beyond the box for receiving the last wheel of the series already described, the connexion with which gives motion to the roller *b*. A slider *c* is attached to the interior of the box, and capable of nice adjustment by a screw or otherwise. The lower end of the slider, which comes in contact with the roller, is formed with a tongue that enters into the groove, and the adjustment of the opening between the point of the tongue and the bottom of the groove determines

the quantity of seed to be delivered. The expense of this machine, in consequence of the wheel-gearing, is greater than that of the machine above described.

3214. *One-rowed turnip-drill*.—These machines are suitable for the larger class of farms, such as those which employ two

or more pairs of horses; but for farms of a small class, having only one pair of horses, a smaller class of machine might answer the purpose; and on this account I give the perspective view of a machine which sows one drill at a time with seed alone in fig. 258, which consists of a frame of timber formed of the two handles *a a* framed

Fig. 258.



THE TURNIP-BARROW FOR SOWING ONE DRILL.

upon a broad transverse bar which carries the seed-box. Besides the broad bar, a round stretcher is introduced near the point of the stilt, chiefly intended for the attachment of a drag-rope; an iron axle is placed below the frame, running in bushes or small pillow-blocks, and the two wheels *b b* are fitted to it, one of them fixed, the other running free. Two iron legs *c c* are bolted to the stilt, with stretcher and braces to render them steady. A toothed spur-wheel *d* is fixed upon the axle, and this acts upon another *e* of equal size fitted upon the spindle of the seed-barrel, which last is of the same construction as fig. 255. The seed barrel is mounted in the case *f*, and the wheel *e* can be disengaged from the driving-wheel. The bottom of the seed-box is formed into a funnel, terminating in a director-pipe, as seen at *d*, which descends into the sheath of the coultter *h*. The coultter is simply a bar of hardwood, set in the transverse bar of the frame; and fixed at the proper position by means of a wedge, and shod at the bottom with a strong sheet-iron sheath. One man pushes the machine forward along a drill by the stilt, and a boy or another man pulls it forward by means of a rope.

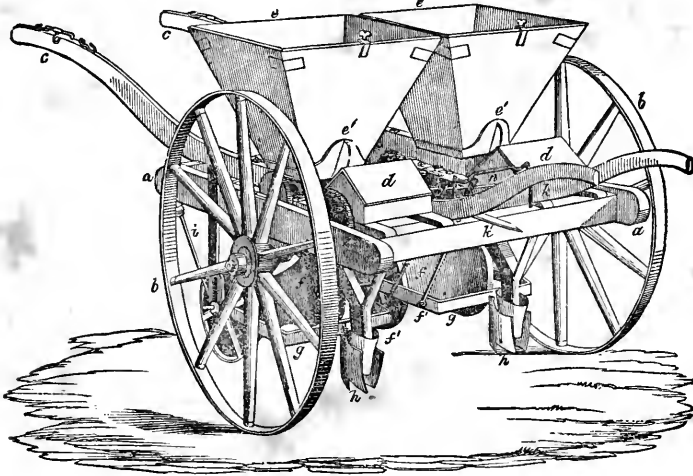
The pull may be too much for one man's strength, when a pony or horse should be employed. The price is from £2, 5s., to £2, 15s.

3215. But turnip seed is not always sown alone, it being also deposited along with granulated manures in the drills. Such granulated manure has hitherto chiefly been bone-dust, though certain composts have recently been recommended as substitutes or assistants to bone-dust. Guano cannot be distributed by means of any drill hitherto known, on account of its clammy consistence, which, if natural, may be rather troublesome to get rid of; but if produced by water being poured into the guano, to increase its weight, it may be overcome by evaporation, though the process would certainly be attended with trouble and expense. The practical consequence hitherto of this inconvenience has been to distribute the guano by the hand. Bone-dust is admirably deposited with the machine about to be described.

3216. *Two-rowed turnip and bone-dust drill*.—Fig. 259 exhibits a view in perspective of a turnip-seed and bone-dust

drill, and although apparently of very complicated form, its description may be easily understood from what has already been said of this class of machines. The bed-frame *a a*, is constructed in a similar manner to those of the corn-drills. The

Fig. 259.



THE TWO-ROWED TURNIP AND BONE-DUST SOWING DRILL.

axle of the carriage, which passes across and under it, is supported on pillow-blocks. The wheels *b b* are added to support the great weight of the manure: one of them being fixed dead upon the axle, carrying the latter round with it, and thus forming the mover of the acting parts; the other being left at liberty to revolve on the axle, for the convenience of turning the machine round. The horse-shafts *c c* are bolted to the two foremost transverse bars. The seed-barrels, are enclosed in the boxes *d d*, through which axles pass; and each axle carries a pulley, one of which is seen at *d'*. The two manure hoppers *e e* are constructed with a cast-iron bottom, having a narrow opening, and in length equal to the breadth of the entire bottom for the reception of the manure-distributing wheel; *f f* are pressing rollers, of the same form and dimensions as those of the common drill. Each roller is also furnished with a coulter-frame *g g*, which carries the coulters *h h*, and has also the usual extent of lateral play, whereby they possess the property of adjusting themselves to the drills,—of carrying the coulter-frame and coulter along with them, and of securing the object of the seed being always sown directly in the middle of the drills. The pressing-roller axle is sup-

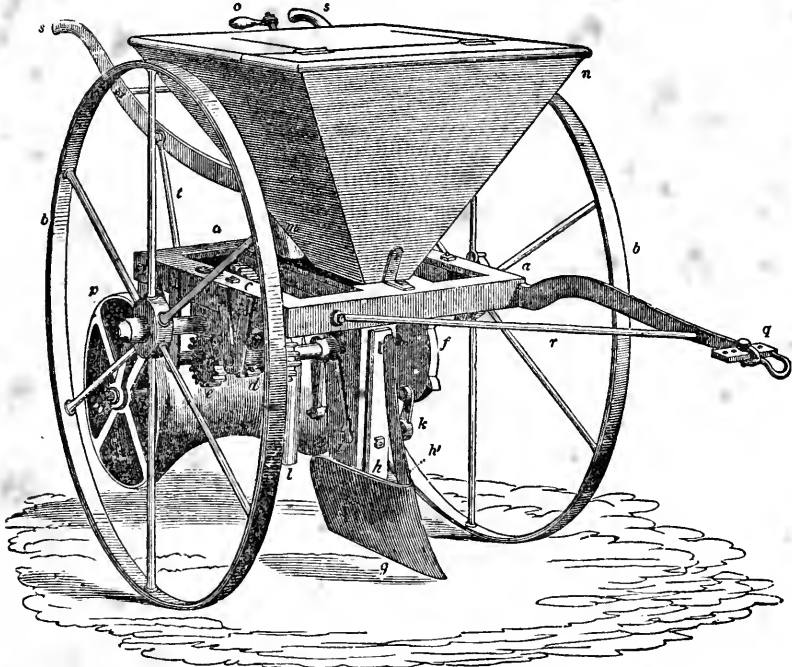
ported by the iron pendants *i*. Two lever handles *k k* are jointed to the front bar of the bed-frame, and to them are attached the connecting rods *f' f'*; whose lower ends bring the operation of the coulters under the control of the person who takes charge of the levers *k k*. An iron lever is also jointed upon the front bar: its handle, extending backwards to *k'*, serves to disengage the action of the manure-distributors from the motion of the main axle; and as the motion of the seed-barrels is taken from that of the manure-distributors, all the secondary motion ceases on the movement of the lever *k'*, and is again brought into action by moving it in the opposite direction. The motion of the manure-distributor is conveyed by small spur-wheels, and the seed-barrels are driven by separate chains from the shaft of the former. These wheels are so placed in relation to the opening of the hopper, as to be quite close to the fore-end of the opening, while an aperture is left at the opposite end sufficiently large to pass the largest allowance of manure to be given out; and in order to graduate this quantity, a sliding sluice *e e* is attached to that side of the hopper, and is adjusted by means of a screw at the top. By these means, the

the drill. This object has been attained by the drop-drill, as it has been called, because it drops the manure in small quantities at determinate intervals; and the best that has yet appeared of that form is that introduced to public notice

by the Messrs Smith of St Ninians, near Stirling.

3220. This improved one-rowed drop-drill is represented in perspective by fig. 261. In this machine the general prin-

Fig. 261.



SMITH'S DROP-SOWING DRILL.

ciple is, that a metal trunk receives the manure from the ordinary distributing wheel, and being provided with a valve, capable of being opened and shut at certain intervals, the manure is retarded in its descent within the trunk by means of the valve, until the requisite quantity is collected, when the valve, being suddenly opened, makes the deposit, and is again shut. The bed-frame *a a* is supported on two carriage wheels *b b*, to ease the pressure of the manure upon the tops of the drills. The bed-frame has a central bar, which supports the manure hopper *n* and the manure trunk behind it. The axle of the wheels carries a spur-wheel *c*, which acts upon the pinions *d* and *e*, the first being upon the shaft of the manure-distributing wheel, the second upon that of the seed-distributor. The shaft of the pinion *d* extends beyond the manure-dis-

tributing wheel, to carry the wiper-wheel *f*. The sheath *g* slides up and down the shank plate *h*, to regulate the depth at which the manure should be deposited. The discharging valve within the trunk carries at the end the lever *k*. The lower extremity of the seed trunk is seen at *l*. The regulating screw for discharging the manure out of the hopper is at *o*. The pressing roller is *p*, which, following, covers in the seed and the manure, and consolidates the soil in the drill. Though the machine only sows one drill, it requires to be drawn by a horse; and that the horse and man who drives him may walk in the bottom of the drill, the bar to which it is yoked is placed at one side of the bed-frame, of which *q* is the yoke-bar or beam, supported by the stay-rod *r*, and *s s* are the handles supported by the stay *t*.

3221. In sowing with this machine, the effect of the combination of its machinery is to be thus understood. The carriage-wheels being three feet in diameter, or 113 inches in circumference, the wheels will turn once round while the machine passes over that space. The main spur-wheel will also make one revolution in the same space; but, as the pinions upon the axle of the seed and the manure distributors are just half the diameter of the other, they will each make two revolutions while the machine is moving over 113 inches; and as the wiper-wheel has six wipers, each revolution of it will lift the valve six times, or twelve times in the space of 113 inches, making twelve depositions of manure in that space, which is $9\frac{1}{2}$ inches to each nearly. In the same manner the seed-distributor, which also makes two revolutions in the same time or space, and as it has six little cups or perforations, it will discharge twelve times, as before, in 113 inches. Then, the seed-depositor being placed $9\frac{1}{2}$ inches distant and behind the manure; and as they are arranged to drop at the same instant, the manure-deposit will be always one space in advance of the seed, and the seed will be dropped over the immediately preceding deposit of manure.

3222. The saving of manure in the first instance, by the use of the drop-drill, appears to be considerable, since it has been frequently asserted that 10 or 12 bushels of bone-dust per acre will produce a braird equal, if not superior, to 16 or 18 bushels put in by the continuous mode. In the view of its more general adoption, the form of the machine must be changed from the single to the two-row drill, a change of which it is quite capable, and which may be done at less than double the expense of the single machine. In its present form, the process is too slow for large farms; and on any such, the additional expense of the double machine is not to be put in comparison with the advantages of despatch in sowing. The price of the single machine is about £6; if extended to two rows, the price would not exceed £10.

3223. Apparently some advantages are derived from this successive mode of depositing the seed and manure, espe-

cially with those manures held to be the most active, such as bones, guano, and the like—for here the manure is laid into the rut, the earth of which partially falling in and mixing with it, thereby reduces its intensity; and the seed is dropped upon this mixture, instead of falling directly amongst the manure, as is generally the case with machines which sow the seed and manure continuously. It is said that a more speedy and vigorous vegetation is produced by this than by the continuous mode of sowing; but it may yet be deserving of observation, whether the more speedy development of the young plant does not arise from the circumstance of the seed, under this mode of treatment, being deposited nearer the surface of the soil, than it is when put in immediately behind a coulter; and, viewing the subject in this light, it may suggest the question, whether deep sowing alone may not be the cause of the protracted vegetation so often and so seriously experienced in the turnip crop? It is well known that the vegetation of all seeds is decidedly affected by the depth at which they are planted in the soil, so much so, that at or beyond certain depths the seeds lie perfectly dormant; the depth, however, requisite for producing this effect varying considerably with the nature and qualities of the seeds. Thus, a potato-tuber will vegetate if within 2 feet of the surface, but the process will be very much retarded; the seeds of some Cruciferæ, again, to which family the turnip belongs, are supposed to become dormant, though not dead, at the depth of ordinary ploughing. There need be no surprise, then, though we should find the vegetation of the turnip retarded to the extent of days, or even weeks, from the seed being deposited at 2, 3, or even 4 inches, as is sometimes done, below the surface. The subject, as regards the turnip crop alone, appears to me deserving of careful experiment, and, if determined in the affirmative, much disappointment and loss may be prevented by adopting due precautions to insure sowing at proper depths. But independently of the consideration of the relative positions of the seed and manure, which are favourable, there are practical objections to dropping the manure at wide intervals. The intervals should vary according to the kind of turnip sown. Swedes should be placed more apart than yellow or white turnips,

and the last rather wider than the yellow, because they have generally larger bulbs. Whatever distance the intervals may be, it is evident that the young plants, which have sprung directly from the influence of the manure, will be more forward in growth and larger in size than those which have risen from the soil alone between the heaps of manure. All the plants, therefore, should be removed from between the heaps of manure, and only one plant left at each heap. But suppose that a careless field-worker should remove all the good plants from a heap of manure, a gap would be left in the crop of double the proper distance, and the loss will be irremediable; but when such a mistake occurs in a continuous deposition of manure, little loss will accrue, because the adjoining plant has as good a chance as the one removed by mistake, to advance in growth, and therefore to supply the deficiency. The growing plant, too, will afterwards have a better chance of obtaining a full supply of food when it is distributed continuously, by sending forth its fibrous roots into the space around it not occupied by plants, than when confined to food within the limits of a given space. We should expect the success of a plant in the former position to be as great as in an open border, when compared to the state of another plant with its roots confined within the limits of a flower-pot.

3224. I would make a few remarks on the effects of the too common disuse of the hind rollers of the turnip-drill. There is no doubt that rollers make the best work when the surface of the ground is dry, and as little doubt they make bad work when the surface is damp, and that when the surface is wet they should not be used at all. The finer the surface of the ground has been pulverised, those different effects of rollers are the more evidently manifested. This being the state of the case, when the ground is damp, the sowing of the turnip-seed will be delayed until the ground become sufficiently dry for the use of the roller, and, in the delay, the fate of the crop may be materially affected for the worse. On the other hand, the disuse of rolling causes a positive inconvenience in the singling; so that it is worthy of consideration whether the inconvenience is so

great as to induce to the employment of the rollers at all times. The mechanical effect of the hind rollers is to fill up the rut made by the coulters, and to smoothen the top of the drills. Now, the utility of this smoothening and compressing of the top of the drills is, not only to prevent the drought reaching beyond the surface of the ground—which, in both light and strong soils, is an advantage—but to render the singling of the young turnips more easy and certain; and after the sides of the drills have been pared by the scuffer, fig. 262, it will be found that the turnip-plants are much more easily singled when the tops of the drills have been smoothened than when left rough with a rut; because the hoe displaces every individual plant more certainly when on the surface than at the bottom of a rut, where the plant is comparatively out of reach, and partially out of sight of the field-worker. A larger portion, too, of the drill is pushed away with the hoe when singling is performed in the bottom of a rut; the dung is more apt to be torn up along with the plant; and the plants cannot be singled so young; for, until they have reached a certain height *above* the edges of the rut, it is not safe to touch them with the hoe at its bottom, whereas on a smooth surface they may be singled very young. The advantages of a smooth surface are not imaginary, for I have experienced all the inconveniences enumerated when I have been induced to remove the hind rollers in damp weather, from the desire to proceed with the sowing before the ground was perfectly dry on the surface. A scraper is of use on the hind rollers, but still they cannot make the rollers work *well* when the ground is damp. On carefully weighing the disadvantages of both modes, I am convinced of the superiority of the smooth drills, inasmuch as I consider the most proper singling of the plants to be of much greater consequence to the future crop than any injury that can arise from waiting 2 or 3 hours in the morning until the ground becomes dried with the sun and air; and I would much rather work that time longer in the evening, than sow turnip seed in land in a damp state without the hind rollers. This resolution, however, would not induce me to fix the rollers so as they could not be removed, for the option of removal

should rest with the farmer, who should act according to the particular state of the weather and the soil.

3225. The land having been dunged and drilled, and the sowing machine prepared, let us first take fig. 254, which sows the turnip seed alone, and the first use made of it is in sowing the Swedish turnip seed. The quantity of seed required, I have said, is 3 lb. the acre, because, the seed of swedes being large, that quantity is given to secure the necessary number of plants against all the chances of failure connected with old dead seed, and the numerous casualties to which it is subjected in the soil by insects, cold, and drought. The seed-box of the sowing-machine should never be above three quarters filled with seed, to allow the seed to fall easily through the holes. Swedish turnip seed requires a larger sized hole of the seed-box than either yellow or white turnip seed. A tin funnel is the most convenient means of filling the seed-box from the seed-bag. The drills should be browned or dried on the surface before the machine is made to sow the seed, as otherwise the coulter will make a large and rough rut in the drill, and the covering rollers will become clogged with earth; and the rough rutting would be bad work, even with the covering rollers removed. One of these machines could sow a great breadth-of land in a day, but it is seldom that it can be employed throughout a whole day, for two reasons: one is, that the soil is seldom in a dry enough state in the morning to be sown with it; and the other reason is, that a sufficient quantity of land will not be dunged and split in the course of a day to keep a machine going constantly, because one plough can only split one-third more land in a day than it can plough, so that 3 ploughs will only split 5 acres at most of drills in a day, and thus one machine could hold 4 ploughs splitting drills; and as the dunging is carried on at the same time, few farms are so large as to employ 4 ploughs splitting drills. In like manner are the yellow and white turnip seeds sown through smaller holes of the seed box; and as both those seeds are small, $2\frac{1}{2}$ lb. the acre of each will suffice. At every landing the sowing gear is disengaged, and put on

again when the machine begins to sow new drills.

3226. The same remarks apply to the use of the one-rowed sowing machine, fig. 258, when turnip seed alone is sown, with a full manuring of farm-yard dung.

3227. When bone-dust is used as the sole manure for the turnip crop, the land is somewhat differently prepared for the seed from what has been described for farm-yard manure. On the land being ready to be drilled up, it is drilled at once in the double method, (2397,) and is then ready for the manure and seed to be deposited in it by the sowing machine. It would not answer to drill the land by the single method, as the drills would be too imperfectly formed for the seed.

3228. The machine for sowing bone-dust, along with the seed, has been described under fig. 259. The bone-dust is most conveniently taken to the field in a cart, fig. 175, the body of which slopes on its trans on a head-ridge when the horse is taken out. A field-worker takes the manure out of the cart in a rusky, fig. 201, which is most conveniently filled with a lime shovel, fig. 233. Both hoppers are filled to the top with the bone-dust: their exact contents should have been previously ascertained; and the seed-boxes are filled in the manner described above (3225.) When the machine has been entered by the horse at the end of the first two drills, the sowing gearing is put on and the horse bid to go on, the man guiding the machine by the handles. To ascertain if the machine is sowing the proper quantity of the bone-dust in the acre—namely, 16 bushels, or two quarters—it should be calculated beforehand how many yards the known quantity of bone-dust in the hopper should sow along the two drills to distribute the proper quantity: one bushel will sow 30 yards 9 inches along two drills, at 16 bushels the acre.

3229. The action of bone-dust on the soil, and its consequent power to produce a large turnip crop, is not yet well understood, the means employed being apparently so inadequate to the results received. Up to a certain quantity used, this manure

has an evidently beneficial effect, but, beyond that quantity, no apparent benefit is derived from its use, in as far as at least as the crop is concerned. I have tried to raise turnips with different quantities of bone-dust, varying from 12, 16, 20, to 24 bushels to the acre, and found the crop improved up to 16 bushels; but the quantities beyond that, even to 24 bushels, produced no greater effect on the turnips in the same field, and on the same sort of soil, than 16 bushels. More than this, my late agricultural preceptor, Mr George Brown, when he farmed Hetton Steads, in Northumberland, raised as good crops of turnips, as did 16 bushels of bone-dust, with only 8 bushels of bone-dust, combined with an indefinite quantity of sifted dry coal-ashes; and yet 8 bushels of bone-dust, or an indefinite quantity of coal-ashes, when applied separately, produced a very poor crop of turnips. It is therefore unnecessary, in so far as the crop of turnips is concerned, to sow more than 16 bushels of bone-dust alone, or 8 bushels with coal-ashes, or street manure.

3230. In some parts of the country, particularly on the Borders, bone-dust is sown by hand either along the drills made up in the single way (2389,) and which are then split in the double way (2397,) imposing the trouble of a second drilling; or it is sown on the flat ground, and covered by drilling in the double way. In both cases the turnip seed is sown afterwards by itself, with the common two-rowed sowing machine. The only reason I have heard in favour of sowing bone-dust by hand, instead of machinery, is the saving the cost of the machine; but whatever advantage is gained by this saving, it is, I think, evident that the machine must deposit the bone-dust much more regularly than the hand; and as to the cost of a machine, the saving must be trifling, as hoppers for containing bone-dust can be attached, and made to be removed at pleasure from the ordinary sowing-machine. I always used a machine of this form myself, and found it to answer the purpose well: it was constructed like fig. 259. But, in a case of this kind, accuracy of work is a more important consideration than the cost of a small machine, although it should only be used for a few weeks every year. There is, besides, the value of the fact, that, the

nearer the bone-dust is placed to the turnip seed, the quicker does the seed vegetate, and the more the plant is encouraged to grow. In sowing by hand, the manure is not placed near the seed, in so far as the sower knows; and when the seed is sown by itself, after the bone-dust has been covered up by the drill, the sowing-machine is as likely to deposit some of it away from, as near the manure, and hence an irregular braird may be the consequence. Bone-dust, though in contact with turnip seed, does not affect its vitality. Guano, on the contrary, affects the vitality of seeds, and should therefore be applied by the hand at a different time from sowing the seed.

3231. The effect on the soil of so small a quantity of bone-dust is surprising. I have lifted a portion of the manured soil of a drill with my hand before the turnip-seed had germinated, and felt it very warm, and found it agglutinated together in a lump with a greasy matter, and the lump interspersed partly with a white mould, and partly with minute fibres of plants. When the turnip seed germinates, which it will do in 8 or 10 days, according to the state of the weather, its radicle strikes into the greasy mass of earth, and sends out an immense number of white fibres around and through it. Its cotyledons then expand upwards, in two rudimentary smooth leaves, and immediately thereafter the two true leaves appear; and these last are called *rough* leaves, because they feel rough on account of the small sharp spiculæ which cover the surface of every leaf of the common turnip. The rudimentary leaves of the Swedish turnip are not rough but smooth, the plant not being a true *turnip*, but a species of cabbage, which all have smooth leaves. They are, nevertheless, termed the rough leaves. The smaller bone-dust is ground the more active it is as a manure, because it then mixes most intimately with the soil, though its action continues a shorter time; and, on the other hand, large or *drilled*, or *inch-bones*, as they are called, remain longer in the soil undecomposed, but produce less immediate effect. On these accounts, bone-dust is the more valuable manure for turnips, and inch bones for the cereal crops.

3232. A better method than using bone-dust alone, as a manure for turnips, is to

apply it in conjunction with farm-yard dung. The benefit accruing from the combination of the two manures is, that the bone-dust promotes the quick germination of the turnip seed, and supports the plant until it sends its roots downwards, where it finds the dung ready to sustain its future growth. The quantity of farm-dung, when thus used, is reduced to 10 or 12 tons, and the bone-dust to 8 bushels the acre. The result is generally very satisfactory; and, even on strong clay soils, a crop of swedes may be raised with this mixture of manures. The seed and bone-dust are sown with the bone-dust sowing-machine, fig. 259, taking care not to dip the coulters so deep as to disturb the dung below, which should have been well rotted, and covered in with the drills formed in the double method, (2397.)

3233. Of late it has been deemed better to use bone-dust in combination with sulphuric acid, or rather the oil of vitriol as sold in the shops, than by itself, or with farm-yard dung. The effect of the action of the acid on the bones is to reduce them to a pulpy mass, which is made in this manner:—Mix a given quantity of vitriol with twice its bulk of water, in any convenient vessel, when the mixture will evolve a considerable degree of heat. Put into a large tub or trough double the weight of bone-dust as of acid used, and pour the mixture of acid and water gradually, and by times, over it. An action will soon be observed arising from the escape of carbonic acid gas, and in time, on stirring, the bone-dust will be entirely dissolved, and form a mass with the acid and water. The mass may be dried with riddled sawdust, dry ashes, or fine dry vegetable mould; and the granulated powder thus prepared, may be sown either by itself, or in combination with farm-yard dung, with the bone-dust sowing-machine, fig. 259. Uncrushed bones will answer the purpose as well as crushed, but the acid will take much longer time to act upon them.

3234. The material thus obtained has been called the superphosphate of lime, but a more correct name would be *sulphated bones*. It is found to have a greater power of raising turnips on clay soils than bone-dust. No doubt bone-dust operates more beneficially on light (347) than on heavy

soils, (346;) and if a substance can be easily made which will secure a crop of turnips on heavy land, it is a very valuable commodity.

3235. Sulphated bones may be used alone in raising turnips, or in conjunction with farm-yard dung. When used alone, perhaps 200 lb. of bones and 100 lb. of oil of vitriol may suffice for an acre, for the quantity has not yet been definitively settled by experiment; but it is better to use it with farm-yard dung, when 10 or 12 tons of dung and 1 cwt. of bones, with 56 lb. of vitriol, will be sufficient for the acre to raise a fair crop on comparatively heavy land.

3236. According to some experiments made by Mr Pusey, and at his request by others, it would appear that, when bones have been fermented with coal-ashes and even pure sand, their efficacy is stronger than in the form of dust, probably from the fermentation disintegrating the bones to the smallest degree, and thereby rendering them more easily mixed with the soil. The method of fermenting bone-dust in this manner is to mix 4 cart-loads of bones with as many of sand, or mould, or sawdust, in a flat-topped heap. The bones should be thoroughly drenched with water, and the other materials moistened. In a few days, such a heat will be generated in the heap as to render it unbearable by the hand. As the outside of the heap will not be heated so much, it should be covered with sand. Whether the heat should be allowed to die out before the heap is used is a point still unascertained, but a large heap makes better manure than a small one; so do unboiled and fresh bones, than boiled or stale ones. Large bones may be reduced by fermentation in this way, by turning the heap over at the end of a fortnight and watering it afresh, and at the end of a month very few whole bones will remain. Broken bones will of course be more quickly reduced than whole ones.

3237. Should this method of reducing bones prove successful, it is a much cheaper and simpler mode of doing so than with vitriol. A farmer tried a comparative experiment for Mr Pusey, and found that 4 bushels of fermented bones gave the same yield of swedes as 16 bushels of bone-

dust unprepared, and 2 bushels of sulphated bones. Mr Pusey himself found by experiment, that $8\frac{1}{2}$ bushels of heated bones and sand, at a cost of £1, 0s. 9d., yielded $13\frac{1}{4}$ tons of turnips; while 17 bushels of bone-dust, at a cost of £2, 6s. 9d., and $4\frac{1}{2}$ bushels of sulphated bones, at a cost of £1, 2s. 9d., only yielded $13\frac{1}{4}$ and $14\frac{1}{4}$ tons respectively; and he also found that, by increasing all those quantities one-half, no greater results were obtained.*

3238. *Guano* has proved itself an excellent manure for turnips, and being as easily procured, and as easily carried and applied as bone-dust, it has become a very favourite manure, and is more generally applicable to every class of soil than bone-dust. It cannot be applied by machine, on account of its clammy state as sold in the market; but it may be sown by hand out of a sheet like corn, and it may be mixed with dry ashes or mould. When used by itself, 5 cwt. the acre are required. When used in conjunction with farm-yard dung, 3 cwt. the acre will suffice.

3239. When applied with farm dung, the land receives a different treatment than when bone-dust is used. After the dung has been spread in the drills, (2749 and 2750,) the grass-seed harrow, fig. 232, is passed a single time along the drills, which has the effect of drawing some of the soil off the drills upon the dung. The guano is then sown by hand over the harrowed drills, at the rate of 3 cwt. to the acre, and it does not come directly in contact with the dung, though it is scattered over the surface of the ground. Instead of the harrows, I have seen it recommended to employ a sort of scraper, which extends across two drills, having two bars of wood shod with iron, which, on being drawn forward by a horse, scrapes the earth from the top of the drills upon the dung in the bottom. Such a device, I have no doubt, will answer the purpose, but it possesses no advantage over the grass-seed harrows. The drills are then set up in the double method, (2397,) and the turnip seed is sown with the common drill, fig. 254, which finishes the work.

3240. It is not an unusual practice in

England to sow turnips *broadcast on the flat ground*, instead of on drills, as in Scotland; and the reason I have heard stated in vindication of the broad-cast method is, that it resisted the bad effects of drought on the land in summer. No doubt excessive drought in summer is inimical to the full development of the turnip, and it is on this account that the turnip crop fails so frequently in Germany; but, for my part, I cannot see how a broad-cast crop can screen the ground from drought more effectually than one in rows, since the plants have to grow and be thinned out to proper distances, and the ground stirred to get rid of weeds, in both cases: and as the weeding is done by hand instruments in the case of the broad-cast crop, it is not so *effectually* done as with horse-hoes in the crop in rows. The dung, being spread broadcast for a broad-cast crop, cannot promote the growth of the crop at its early stage so well as when deposited in rows; and I think it cannot admit of doubt, that the same quantity of manure placed immediately under the seed should promote the growth of the young plant more rapidly than when spread over a large surface of ground. Now it must be admitted, as regards the turnip plant, that the more rapidly it grows in its early stage, the more quickly it will cover the ground from drought, and be beyond the reach of insects—as it is well known, in regard to the habits of those which attack the turnip, that they become innocuous after the full development of the leaves. I do not think that the sowing of turnips in drills renders them invulnerable to the attack of insects, or the injury of drought; but, these effects being seasonal, the drill system places the crop more immediately under the control of the cultivator, inasmuch as it secures to him the whole powers of the manure at once, and enables him to clean the soil in the shortest time with the assistance of horse labour. Besides, the period of sowing the crop should be chosen so as to avoid such casualties. If drought is too great in July, or insects too powerful, the crop should be sown earlier, and though it should reach maturity sooner than desired, it may be stored until the season of consumption arrives; or it might be sown later, as in August, when the genial climate of the

* *Journal of the English Agricultural Society*, vol. viii. p. 418, and vol. ix. p. 530.

south of England—where the nights are warm as well as the day, affording every day the growth of two ordinary days in Scotland, where the nights are always cold—in sufficient time to mature the crop before the end of October, which is as early as the turnip crop is required for consumption in that part of the country—the grass till then continuing good. Were the soil, too, properly cleaned before the crop is sown, comparatively little labour would be required to keep the ground free of weeds in summer, and the drought would not then have much effect upon it. To render the culture varied, part of the turnip crop might be taken after winter vetches, which, on being cleared off the ground in time by feeding sheep, or by cutting for forage, would allow the land to receive a short fallowing before the end of July.

3241. Nor is the much earlier fallowing and cleansing of the turnip land impracticable in England, since the corn crops are frequently cleared from the fields by the end of August, when the stubble could be broken up, harrowed, cross-ploughed, cleaned, drilled, and even dunged, before the arrival of winter, as has been proved in Scotland, by the practice of Mr James Scougall, at Balgone, East Lothian, on the farm of Sir George Grant Suttie, Bart., in the autumn of 1841, when he drilled and dunged good turnip-land, at 32 inches apart in the drill, and otherwise finished its tillage. Purple-top swedes were sown on the 10th of May 1842, the plants thinned to 15 inches apart, and the matured crop was drawn and stored by the middle of September following, when the ground was sown with wheat. On comparing the produce of this mode of culture with the usual one of working the turnip-land in spring, and at the usual distance of 28 inches between the drills and 12 inches between the plants, the ground prepared in autumn yielded, in 429 links measured along a drill, 82 stones of turnips, whereas the land worked in spring yielded only 58 stones, whilst the number of turnips in the 82 stones was only 238, and that in the 58 stones was 276—making each turnip 4 lb. 13 oz. in the former, and only 2 lb. 15 oz. in the latter number. A single horse-load of turnips selected from the

ground prepared in autumn, only numbered 141 roots, and weighed as much as 109 stones, showing the weight of each root to be 10 lb. 13 oz.* This instance proves that land for Swedish turnips may be prepared in autumn, and a heavy crop obtained on drills as wide as 32 inches, and from plants 15 inches apart.

3242. A somewhat similar success attended the trial of raising turnips on strong clay-land, at ordinary distances, by Mr Peter Thomson, Peffermill, near Edinburgh. As soon as the ground was cleared of tares, he cross-ploughed it with a deep furrow early in October; harrowed, grubbed, and drilled it in the single way, (2389,) at 28 inches asunder, but, owing to the unfavourable state of the weather, was prevented applying the dung until December and January, when 32 single horse-loads the acre of street manure were covered in with the common plough. In March, the ground was found in a fine state, but, as it was rather foul with weeds, the drills were harrowed a double tine, the soil stirred between them with the drill grubber, fig. 262, and set up with the double mould-board plough, for forming drills, fig. 214, and again set up by the same, just before sowing the seed of the green-top yellow turnip on the 15th, and of the white globe on the 25th and 26th of May. The yield in autumn was 32 tons of turnips the acre, including tops. The field had been dunged five years before, and twice since top-dressed with 8 bags of 4 bushels each of soot to the acre.† Were such modes of cultivating the turnip adopted in the south of England, I have no doubt certain and abundant crops would be raised in spite of drought and insects, and the slovenly practice of broad-cast culture give way to the more scientific mode of the drill system. After all, it has never yet been *proved* that broad-cast sowing prevents the turnip plant from being affected either by drought or insects.

3243. On strong soils it is difficult to obtain a braird of turnips in a dry season, on account of the hard and cloddy state of the surface of the drills, which is generally induced by the land having been ploughed in early spring in a rather damp state,

* *Mark-Lane Express*, October 17, 1842.

† *Ibid*, November 21, 1842.

and becoming hardened by subsequent drought in May. In these circumstances it not unfrequently happens that the plants come up in a puny state, and very scantily, and are afterwards devoured by the flea-beetle, so that the land is re-sown with white turnips in June.

3244. To avoid such serious inconveniences, it has been recommended to drill up the land in the beginning of winter, to dung it fully, and to let it remain in this state all winter, to receive the frost. In the spring the scuffler, fig. 262, is passed along the drills to kill the surface weeds. The drills are harrowed a little down with the drill harrows, fig. 220, a short time before the sowing of the seed; and the seed is then sown either by itself, or better with the manure-drill, fig. 259, along with sulphated bones, which act more beneficially on strong soils than common bone-dust. By this mode of treating a strong soil, it becomes fine on the surface by means of the frost and air, and is in the best state for encouraging a braird. But it must be borne in mind that unless the land be *clean*, it cannot be so treated; for were it foul with couch-grass, the working and manuring of it would so encourage the growth of that weed, that the summer culture of the turnip plant would be almost impracticable.

3245. It has occurred to me, that one cause of the scanty braird of turnips, in seasons unfavourable to vegetation, is the too deep sowing of the turnip seed. The coulters of most of the turnip-sowing machines are set to go too deep into the soft ground of raised drills, and when they are also immovable, they cannot fail to deposit the seed deeper than desired in such drills. I have made experiments on the germination of turnip seeds, sown at different depths, the comparative results of which I will mention when I come to treat of that interesting subject.

3246. It may happen on account of the state of the weather, or its own condition in regard to hardness, or to foulness from weeds, that the ground cannot be prepared in proper time for sowing the ordinary kinds of turnips when it becomes expedient to sow a kind which will either come to maturity, or stand the winter in a

young state better than the kinds in use. As no turnip is yet known which possesses the latter property to a greater degree than the kinds in use, it is requisite to sow a kind which will come early to maturity, and this the white stone turnip will do, which, though sown late in July, will be ready for use by the end of October. If a few very early turnips are desired, as in September, the stone turnip, sown immediately after the white ones in June, will afford the supply.

3247. It is of importance to fix the relative proportions of ground to be occupied by the different kinds of turnips. If turnips are to be early begun to be eaten, more white should be sown, as they should last to the end of the year; and if turnips are likely to be late in spring in being consumed, more swedes should be sown, to last four months. The intervening period of about a month is occupied with the yellows.

3248. If it is desired to manure a large field with sheep in the latter part of the season, the field should be sown half with swedes, and half with yellows, with white alternating with both. The yellows are led off and stored, while the white are taken to the steading to the cattle, leaving possession of the field to the swedes. If it is desired to manure the field early with the sheep, it is sown with yellows and white, and the white are led off to the cattle, and the yellows left in possession of the field. Thus the *extent* of ground desired to be occupied by any kind of turnip may easily be arranged, and its manuring by sheep secured to that extent with any kind of turnip desired.

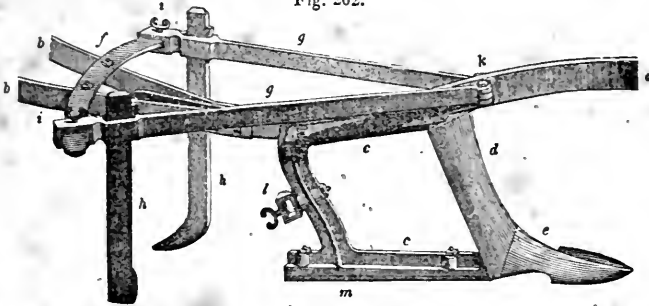
3249. The young turnip plants may be expected to make their appearance above ground in the course of eight or ten days at soonest, and later if the weather is unfavourable to vegetation. When the plants have attained about 3 inches in height, it is time to prepare the ground for their being *singled* at determinate distances. The first preparation is passing the horse-hoe between the rows of plants.

3250. *Horse-hoe or Scuffler*. — The double mould-board plough, fig. 209, is convertible into a scuffing or cleansing

plough, or horse-hoe. To effect this, the hinge-pins of the mould-boards are withdrawn, and the mould-boards removed, when the implement represented by fig.

262, is formed; the portions of the beam and handle being cut off, and the remaining portion of the beam is *a*, and of the handles, are *b b*, exhibiting also their junc-

Fig. 262.



THE BODY OF THE DOUBLE MOULD BOARD ALTERED TO A SCUFFLING PLOUGH.

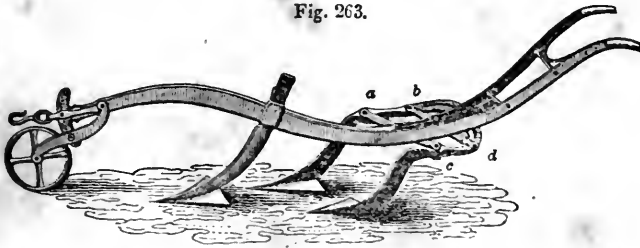
tion with the tail of the beam. The body frame *c c*, is of an irregular rhomboidal form, whereof the front bar *d* forms the shield, and the lower bar, the sole-shoe *m*. The two wing bars *g g* are jointed to a stud that projects from the beam on each side at *k*. A quadrant bar *f* is attached to the two stilts at *f*, and the ends of the wing-bars, having a mortise formed to receive the quadrant, are moved upon this to any required width, and secured by the screws *i i*. A second mortise is punched in each wing-bar to receive the scuffling coulter *h h*, which are thinned off to a knife-edge in front, and bent inward below till the points stand 6 inches to the right and left of the shanks. A double-feathered share *e* is fitted to the head *d* of the body-frame, which completes this simple horse-hoe, and the change from the one state to the other is effected in a few minutes, for, in return-

ing it to the double mould-board state, it is only necessary to remove the scufflers *g g* and *h h*, and the feathered share *e*.

3251. The effect of this horse-hoe in the soil is to loosen the earth between the rows of drills, or, if foul, to under-cut all the weeds that exist in that space, or to such breadth as the two scufflers *h h* may be set; the upright part of these coulters performing a species of paring along the sides of the two contiguous rows. If the land is in good order, and tolerably clean, stirring it with this scuffler will be sufficient; but if overrun with weeds, one or other of the drill-harrows or grubbers will be found necessary to prevent a re-vegetation of the weeds.

3252. Fig. 263 exhibits Mr Wilkie's horse-hoe with parallel motion, in which

Fig. 263.



WILKIE'S HORSE-HOE WITH PARALLEL MOTION.

the two back tines have their tails jointed, at *a b c d*, to two transverse parallel bars, which traverse to a small extent upon

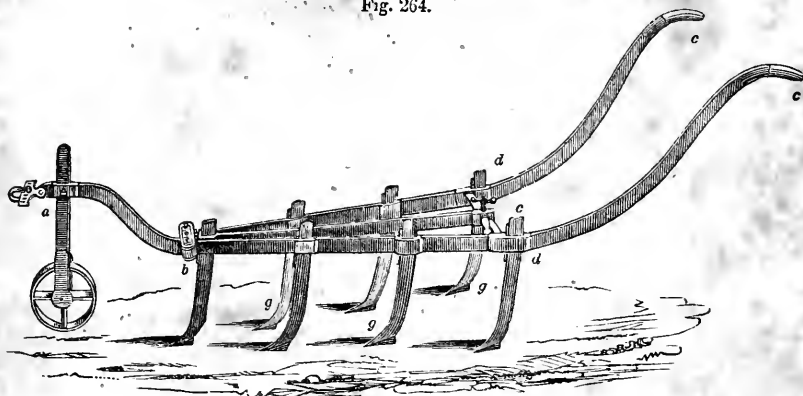
pivots placed in the middle of their length, attached to the tail of the beam. By the motion of these, a perfect parallelism of the

tines is preserved, capable of being secured at any required width by pinching-screws. This is the most perfect mode of adjustment for the tines of a hoe of this construction—three-tined—but it does not apply to those of more than three, and is perhaps too refined for a field implement. The self-cleaning form of the tines has been adduced in favour of this implement, but

the form that may be useful in a great field-grubber is not applicable to an implement such as this; for it seldom occurs, and ought never to be the case, that a drilled green crop is so overrun with weeds as to require a self-cleaning tine.

3253. The common *drill-grubber*, fig. 264, is a light and convenient implement drawn

Fig. 264.



THE COMMON DRILL-GRUBBER.

by one horse. It consists of a central beam *a b c*, the neck part of which is bent upwards, and punched at the front for the passage of the stem of the wheel. The wing-bars *b d*, carry the tines *g g g*, 6 in number, and the central beam carries the front tine at *b*. The wing-bars are each furnished with a quadrant-bar riveted into the wings at *d d*; the tail of the quadrants, passing through the mortise at *c*, are secured by a pinching-screw fixing the wings at any required width. The wing-bars are extended backward, and bent upwards to form the handles *c c*. To the point of the beam is affixed a simple bridle *f* with a cross-web and shackle, giving a small range of yoke right and left. The front wheel, whose office is to regulate the depth of the grubbing, is usually 8 or 9 inches diameter, and the tines *g* are forged with duck feet slightly pointing forward. In many localities this implement is used for all the purposes of horse-hoeing, except the process of paring or of earthing up; and, having cheapness as well as utility as a recommendation, it is very generally approved of. It is, however, subject to variety in the different districts where it is employed: in some it is shortened to 5 tines,

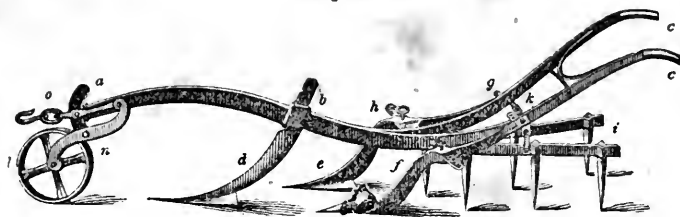
in others lengthened out to 9, and in many cases the tines are plain-pointed. It is frequently also made with the tines standing in a zigzag position; but, except in the second pair of tines, this is of little importance, as those behind the second are sufficiently apart to prevent them becoming choked with weeds. The price of this grubber is about £2, 10s.

3254. In this class of implements, we find a very handsomely constructed one, known as *Wilkie's drill grubber and harrow*, which is represented in fig. 265. This implement is constructed with a beam *a b*, and a pair of handles *c c* attached to the tail of the beam, one on each side. It has no proper body-frame, but is merely a skeleton, the grubbing parts of it being the three tines or coulter *d e f*. The foremost one *d* is set in a coulter-box in the beam, and terminates in a double-spreading feather or duck's-foot point; the two others, *e* and *f*, are continuations of the two wings, which are capable of adjustment by the quadrant-bar *g*. The effect of the tines on the soil is somewhat similar to that of the scuffler, fig. 262. paring and undercutting; but the implement is furnished with an appen-

dage in the attached 6-tined harrow *i*, which completes the operation at one turn. The harrow is capable of adjustment to

depth by means of its suspenders, and to breadth by means of its two small quadrant-bars. The regulation of depth is

Fig. 265.



WILKIE'S DRILL-GRUBBER AND HARROW.

aided by the wheel *l* hung in the shears *n*, which is jointed to the beam at *a*, and to which also is attached a shackle and hook *o* for the draught. The price is £4, 15s.

3255. In stiff soils, the broad-feather shares will with difficulty be kept in the ground; and, from their great length and breadth, will have the effect of consolidating that part of it which they pass over, into a hard crust. The harrow is an important part of the implement, but adds considerably to the draught; and the implement, upon the whole, is too heavy for one horse being able to produce efficient work with it. By lightening the entire structure, and altering the form of the tine, it might be rendered a very useful horse-hoe.

3256. A ploughman is set to work the scuffler, fig. 262, and he takes one of his horses while the other one is resting, each horse working one yoking every day while at this work. On farms having a large breadth of turnips, two scufflers may be thus engaged. As the work of scuffling is easy compared to ploughing, the aged horses, or mares suckling foals, are employed at it. Should the companion to the mare with foal be a horse or a mare without a foal, the mare and her foal are sent to pasture, while her companion works all the day. The steadiest horses, in whatever state they may otherwise be, should only be employed at scuffling, else by unsteady walking the implement may cut up the plants right and left. The ploughman should provide double reins to the horse. In setting the wings of the scuffler, the coulter should be brought to

pare the soil from the plants as near as possible without touching them, and the drier and finer the state of the soil, the nearer they may work to the plants. In rough and damp soil, the clods, raised and disturbed by the coulter, will be apt to fall upon the plants when the coulter is placed too near to them. In scuffling turnips the ploughman requires to be constantly on his guard, to guide the implement in the middle space between the row of plants on each side of him; and on entering and finishing every landing, he should take care that the horse does not turn too sharply upon the head-ridge, and cause the coulter to cut off some of the plants from the ends of the drills. Scuffling admits of walking at the rate of three miles in the hour or more, and is a very expeditious process, when the land is pretty clean.

3257. The scuffling having cleared part of the ground in a yoking in advance, the singling is ready to commence. The implement used for singling turnips is represented in fig. 266, and is named the *turnip-hoe*. It consists of a thin iron plate

Fig. 266.



THE TURNIP OR HAND DRAW-HOE.

a, faced with steel 7 inches in length and 4 inches in breadth, with an eye *b*, attached to its upper edge to receive the shaft *c*, usually made of fir, to make the implement as light in hand as possible. The shaft should not exceed 3 feet in length, though in some parts of the country it is $4\frac{1}{2}$ feet, whilst

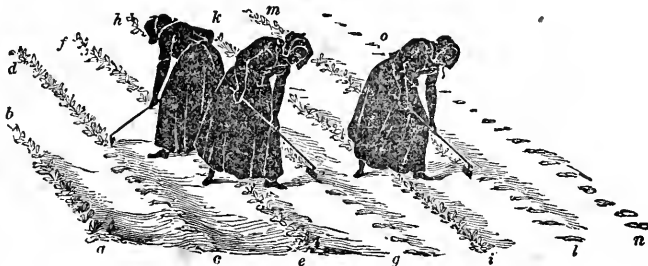
in others as short as 33 inches. The shorter it is the better for the work, as it enables the field-worker to bow closer to the ground; but as this position is really severe for the back, the shaft in some places is made as long as to allow the field-worker to stand nearly upright, in which position, the eye and hand being both far removed from so small an object as a young turnip plant, the worker cannot command the implement so effectually in the thinning process, as when the hands are placed nearer the working part of the hoe.

3258. The consequences are, that numbers of the plants are removed by awkward pushes of the hoe, and the singling is done very slow. Other forms of hoe are in use, such as the triangular, with the handle attached to a hose rising from the centre of the equilateral triangle. This form has been constructed on the supposition that the hoe which possesses three work-

ing faces will last longer than that which has only one; but the utility of the implement is sacrificed for the sake of its durability, as it is evident that the nearly square end of the hoe, in fig. 266, is much more likely to separate a bunch of turnip plants while pushing them away from a single one, in a firm and decided manner, than the sharp point of a triangle, over which the separating plants are apt to fall upon the one which it is desired to retain. The price of a hoe such as in the figure is 2d. the inch along the face, without the helve, and when made entirely of steel, which is unnecessary, it is dearer, while the triangular hoes are 4d. the inch round all the three faces.

3259. The attitude of the workers, the best method of using the hoe, and of arranging the field-workers at singling, is endeavoured to be represented by fig. 267. This work is performed by the field-workers of

Fig. 267.



THE SINGLING OF TURNIPS.

the farm, and they are placed at every 2 rows, beginning at one side of a field, the first worker getting the charge of the first and second drills, the second of the third and fourth, the third of the fifth and sixth, and so on with the rest of the workers. The reason for this particular arrangement, instead of giving a drill to every worker, is, that each may have sufficient room to work, and, having 2 drills each, the whole band of workers have the less seldom to shift their ground.

3260. It is not easy to give a short account of the mode of using the hoe in singling turnips; but the following directions may serve to show the leading requisites to perform that operation in the best manner. On commencing to single a drill *l m*, a foot is placed on each side

of the next drill *i k*, so that the side of the worker is presented to the drill to be singled. The shaft of the hoe is held near its end with one hand, while the other hand, being that of the side in front, is placed a little in advance. The foremost hand indicates whether the person is right or left handed, as it is rare to find a worker that can single turnips equally well with either hand. The foremost hand is steadied by being partially rested on the bend of the leg of the same side, as is particularly shown in the figure *o*. The hoe, on its face being held downwards and in a horizontal position, is pushed chiefly by the weight of the body of the worker against the ground and the plants, when as many plants are removed along with the earth behind them, by the forward push, as the length of the face of the hoe

covers; and in this action the plant destined to be left single falls over if tall, or a little to one side—partly from the want of support of the other plants, and partly from taking away some of the soil from its root. The body of the worker is then brought back to its former position, and thus an oscillation of it forward and backward is maintained in the act of singling. In pushing away the next portion of the plants, one side of the hoe takes care not to touch the plant last singled, while its other side covers the plants next to the one intended to be left growing, which also falls over, and is left *single*, and so on, plant after plant. The leaving the preserved plant *single* constitutes the difficulty of the operation; for, if attention and dexterity are not both exercised, the plant will be dragged up by the roots with the slightest hold by the hoe of a portion of a leaf; and although the leaves are not touched, its stem or root may be intertwined with those of the adjoining plants.

3261. It is found, that the best mode of avoiding these difficulties is to single the plants before the leaves of each plant become so much expanded as to be confounded with those of the adjoining plants, or the stems become so drawn up as to intertwine with those of the others. It is also found, that in pushing the hoe is a much more certain mode of leaving the plants *single* than in drawing it towards the worker.

3262. The plants are represented on their sides in the row *n a*, fig. 267. They receive no injury by falling over, and if the weather is at all favourable, they will have nearly recovered their upright position by the following day; and it has been ascertained that all that portion of the stem which was drawn out of the earth, being the part left exposed above the ground, is converted into bulb.

3263. When the first row has been singled, the second is singled, by the workers moving in the opposite direction from the first; and, when the second drill has been singled, the bout is finished and the singling of that part of the crop completed. Thus, on going up the drill *l m*, the worker returns by the drill *k i*; on going up *y h*, she returns by *f e*; and on going

up *c d*, she returns down *b a*. All the figures in the cut are represented going up singling the first drills of their stints of two drills each. Only 3 figures are introduced in the cut, but the number of workers employed depends on the size of the farm.

3264. On shifting the workers from one stint to another, the worker next the side of the field which has yet to be singled forms the pivot upon which the rest turn. Thus the worker on the drill *c d*, on finishing the drill *b a*, shifts to the drill next *a b*, not seen in the cut, forming the pivot for the rest to turn, the worker *m* going to the left side of her, and the worker *o* takes up her position on the left side of the worker *m*. This alternate shifting, whilst it keeps every worker in her own relative place, and prevents confusion, divides the space to be gone over by each worker every day equal.

3265. In using the hoe, it is not an uncommon practice, both in England and Ireland, to make regular gaps with it in the rows of plants, and to leave the *singling* to boys or girls by the hand, who thus act as assistants to men, who form the gaps with the hoe. No doubt turnips may be singled in this way, but at greater expense; and it intrusts the selection of the plants to be left *single* to mere boys and girls, who cannot be supposed to know so well as experienced adults the properties which make one plant to be preferred to another. Indeed, I consider the employment of boys and girls in singling turnips a questionable policy, because they cannot work as fast as an experienced band of field-workers; and thus working much slower, as might be expected of all inexperienced persons, they retard the progress of the whole working band, as these wish not to leave their young companions very far behind. The want of skill also causes them to destroy many plants that should have been left, and this is a much greater evil than retarding the work. Two young workers are put for an old one on one drill, but this deranges the balance of the whole band, and does not attain the object desired—of keeping the entire work uniform in time. Rather than this should be done, young workers should be put by themselves in another part of the same or another field. Girls must acquire a knowledge of

this work, to make them expert when they become workers; but to acquire their knowledge they should at first be placed in a part of a field which offers peculiar facilities for singling, such as a smooth state of the ground, and the most proper age of the plants; and so circumstanced they should learn to single at leisure, from instructions received from an experienced worker who superintends their work.

3266. Singling turnips should only be prosecuted when the ground is dry, and the plants themselves also dry, as they then separate from one another and from the ground more readily. Whenever the ground becomes cloggy on the hoes, even with a slight shower, the work should be suspended until it again becomes dry enough.

3267. In Scotland the distance between the rows of turnips has been fixed on, conventionally no doubt, at 27 inches, which is a very convenient distance for drilling up the land in the first place, with the common or double mould-board plough; for dunging it with the ordinary tilt cart of the common width between the wheels; and for working the implements employed in turnip culture, such as the sowing drills, and the succeeding scufflers and drill-harrows. On a consideration of the size of the bulbs of turnips, and the nature of the respective kinds of turnips cultivated, the distances fixed on between the plants in the drill are 12 inches between the plants of Swedish turnips, and 9 inches between those of yellow turnips and white globes. Where the soil is naturally fertile, and sheltered, and known to promote vegetation generally in a luxuriant manner, those distances may be increased to the manifest enlargement of the plants and bulbs—so that the matter of distance must be left to be fixed, in each case, by the judgment of the farmer, in the circumstances in which the particular crop is placed.

3268. From what I have said of the effect of 1 or 2 inches between the turnips decreasing the weight of a crop by several tons per acre, in (878,) the singling of this crop ought to be regarded as one of the most important operations that demands your attention. If you wish to single the plants of white globe

turnips to a distance of 9 inches, and of those of Swedes at 12 inches, the first consideration is, whether the plants have braided so equally over the field as to allow you to preserve those distances between them. Being satisfied that the germination of the seed is pretty equal over the field, it ought to be your endeavour to single the plants at the stated distances of 9 inches for white globes, and of 12 inches for swedes. The hoe, fig. 266, commonly in use is 7 inches long in the mouth, so in either case plenty of room is left for the hoe to play between the plants. If *care were really bestowed* in the use of the hoe, there cannot be a doubt but that the plants would grow at the stated distances, and produce as weighty crops, at the respective weights of bulb, as are indicated in the table in (877.) In like manner, were the after hoeings of the crop to receive as much attention, no cutting away the single plants, and no making of blanks would occur, and the estimated weight of the crop would be realised in every case. But instead of bestowing care, field-workers are too often left to themselves—when talking, the proverbial failing of women, occupies their attention more earnestly than the work intrusted to them. Plants are pushed away without regard to the space left between them; and, even when superintended, many women are so disingenuous as to stick the plants they cut into the places they grew on. In gravelly soil it is difficult for the best workers to use the hand-hoe well, as a corner will sometimes slip off a small stone, and cut through or remove a plant against the will of the worker. In all stony soils particular attention is required in the singling and hoeing of the turnip plants. Instead, therefore, of stewards being anxious merely to gather a large number of field-workers to the singling of the turnips, their anxiety should be evinced to obtain a number of practised hands, in whom they can place confidence for their attention and skill.

3269. Should blanks occur in the germination of swedes, either from loss of vitality in the seed, or from the effects of the weather, they may be filled up by transplanting those taken out, which will grow as well as the common cabbage; but the true turnip, the white globe or

yellow, does not transplant, and any attempt to fill up blanks with them only ends in disappointment. When first introduced into this country, the plants of swedes were raised from seed sown in the garden, and afterwards transplanted in the field; but any such preparation is unnecessary, as the best of those which were pushed away in the singling are taken. I have repeatedly tried to fill up blanks in drills with carefully removed plants; and although most of them grew, they never attained the size of those raised direct from the seed. Mr Howison of Crossburn House, Lanarkshire, adopted a mode of transplanting swedes on strong land, which deserves attention, and may be extensively practised in a season unfavourable to the growth of the swedes on such soil. "In an open piece of ground," says Mr Howison, "I raise drills at the distance of 12 inches from centre to centre, in each of which I place a layer of short dung, closely laid on, on which the turnip-seed is pretty thickly sown, and afterwards covered with $\frac{1}{2}$ inch of fine mould. The breadth of the drills at top should not be more than 4 inches, so that the earth and plants may be more completely lifted together by the spade, when to be transplanted. The time of sowing should be regulated according to the purposes intended; and as a fall of ground converted into drills will produce plants sufficient for transplanting 3 or 4 acres, it is better always to have a superabundance. As to the best age for taking up the plants, I have found no difference in their success from the time they have got their proper leaves, until they are 3 or 4 months old; however, those intended to remain long, should be thinned out in the rows. I need scarcely mention, that in dry weather they should be carefully watered, which in so small a space can easily be done. Having provided a wheel-barrow, a garden spade, and a couple of flower-pot saucers of a large size, I with the spade lift up its breadth of one of the drills, taking care that the spade enters below the roots of the plants. This spadeful is then carefully placed in the barrow, and the same operation is repeated until the quantity of plants wanted is taken up. When that is done, they are then removed in the barrow to the field, where they are transplanted with the implements above men-

tioned. It is necessary for expedition that two persons be employed in the transplanting—one to prepare the plants, the other to transplant them. One spadeful is then taken from the barrow, and with a knife divided into three or four pieces, one of which is taken into the hand and carefully drawn asunder, so as to lay open the roots of the plants with as little injury to them as possible, and taking hold of the leaves of the one that appears uppermost, draw it gently out with as many of the little balls of earth and dung adhering to its tender roots as practicable, and place it in one of the saucers. In this way, when the saucers have been carefully filled with the plants laid in regular rows, the transplanter may commence his operations. He should then, with a short dibble not thicker than his finger, make a hole which should only reach to the dung; and then lifting up a plant by its leaves drop it into the hole, and with the fingers of both hands press the earth gently around it. In this way two drills may be planted at the same time. His follower with the barrow will be able to supply him with prepared plants; and, from my experience, the two men should be able to finish one rood of ground in the course of the day, if the plants are 8 inches distant from each other. I may here warn the transplanter against using plants that have not one or more balls of dung or earth adhering to their roots; for if he does, the chance of their growing will be very small." The advantages attending this mode of transplanting swedes are stated by Mr Howison to be three:—"It enables the farmer to fill up the blanks of a turnip or potato field with good plants of swedes. It is more certain of procuring a crop than sowing the turnips over again: this was exemplified on the farm of Green Burnside, Lanarkshire, in 1839, tenanted by Mr James Cassie, when in October of that year the crop that had escaped the ravages of the fly was excellent; the transplanted very good, but the turnips not so large in general as the first. The third advantage is, that, although sown on the same day as the others were transplanted, none attained the size of an egg, which I believe is always the case with late-sown turnips, although the result is difficult to be accounted for. I may, in conclusion, men-

tion another advantage, that it is *best* performed in *wet* weather when all other field-labour is at a stand. I consider rainy and cloudy weather as of the utmost importance to successful transplanting; and so much so, that I prefer waiting weeks to attempting it in sunny and dry weather.*

3270. The quantity of work done in singling turnips varies in different parts of the country. In the midland counties of Scotland it is estimated to take 3 women to single 1 Scotch acre in a day of 10 hours, and there the long-shafted hoes are in general use, and the women work with their backs upright. In other parts one woman will single half an English acre in a day of 10 hours, and there short-shafted hoes are used, and the women work with bent backs. One summer I superintended 16 field-workers, and they singled about 90 imperial acres in 8 days of 10 hours each, which was equal to 2 roods 32 poles a-day to each worker. This is above the average rate of work, but the weather was exceedingly fine all the time, the land mellow and dry, the plants of a proper age, whether of swedes or of white globes, and the women were all experienced hands. I set one of them, a steady hand, to lead the band, whom she carried on like clock-work. She herself preferred to work with a hoe only 33 inches in length, which allowed her to bow down to her work, which she performed, in consequence, in the most perfect manner. The hoes of the rest were 36 inches in length. A rest of 20 minutes was given them at each mid-yoking. If the time occupied in resting be deducted from the 8 days, the work done was exactly 3 roods to each worker every day. To save fatigue in walking home at the end of the mid-day yoking, they brought their dinners to the field, consisting of barley and pease bread, and a bottle of milk. I took my bottle of milk and loaf of home-made bread to the field, and enjoyed the repast at the hedge-root with genuine relish, in as light-hearted company as ever undertook laborious work.

3271. At these rates of work, the singling of turnips in Scotland costs from 2s. to 1s. 2d. the acre in the drill system.

3272. In England the singling of turnips in broadcast costs 6s. the acre, and the second hoeing 2s. the acre. In drills the cost is from 2s. 6d. to 5s. the acre with horse-hoeing: and in taskwork from a halfpenny to one penny the 100 yards along a drill; and the second hoeing from a half to two-thirds of the singling.

3273. After the plants have been singled, the drill-grubber, fig. 264, is used, with a single horse, between the drills, to level the lumps of soil which have been pushed away with the hoe, and to shake the clumps of plants asunder that they may not continue to survive, which they would, were they not separated, if the weather proved favourable to growth.

3274. The field-workers then *hoe* the ground, by which they remove the weeds from *between* the plants, and loosen the soil immediately *around* them. Each worker takes one drill, not two, as in the case of singling, because, hoeing close together, they can see at once whether all the ground has been hoed over, which it should be, whether a weed is seen or not. The hoeing is done by setting a foot on each side of a row of plants, and, grasping the hoe short, the earth is loosened with it around every plant—care being taken that none of the plants are cut through by the root under ground with the hoe. Each worker taking a row of plants between her feet, there is no chance of her jostling her neighbour. All plants left double in the singling are removed by the hand, and every weed pulled by the hand which grows too near any plant for the hoe to remove, and if its removal were attempted by the hoe, it might cut the plant through. The hoeing should be begun before the weeds become too strong, though the singling should not be interrupted for the sake of the hoeing.

3275. When the hoeing has been accomplished—and it should be conducted with much care—the scuffer, fig. 262, is again passed between the rows of plants, to pare away a little of the ground from the plants with its curved coulter, while it undercuts the roots of every weed that may be remaining. Such a paring was

* *P'rise Essays of the Highland and Agricultural Society*, vol. xiii. p. 513.

formerly done with the small plough, fig. 230, when it also bore the name of the paring-plough. Requiring to go a bout between every two rows of plants to pare away the soil on both sides, it performs the work slowly, and the scuffler paring the drills as well, it cleans the middle of the drills better, at one landing.

3276. A second hoeing, similar to the first, finishes the manual operations of the turnip culture. This hoeing is quickly performed, as, by this time, very few plants will have been left double, and the weeds will have been thoroughly eradicated; and, if not, the weather must have been unfavourable for their destruction. Both this hoeing and the first may be at times retarded by the workers having to attend at hay-making, as it unfortunately happens that turnip culture and hay-making have to be conducted at the same time. And even the singling of the later-sown turnips may be retarded by the hay-making. On account of such conflicting operations, the ingenuity of the steward is, at this season, much taxed in arranging the field-labourers, so as to avoid the least loss in the condition of the crops respectively requiring immediate attention.

3277. The time has now arrived for *setting up* the drills with the double mould-board plough, fig. 209. I am of opinion that this, in most cases, is an unnecessary piece of work; and certainly, on dry turnip-soil and on thorough-drained land, it is so, for two reasons—namely, that flat ground is the best form for sheep to eat turnips upon in winter; and that, on a considerable inclination, hollow drills serve only as channels for surface-water to carry away the best of the soil to the bottom of the inclination. There is, besides, the objection of setting up or working in any way amongst turnips after the leaves are spreading across the drills; and this objection is founded on a fact connected with the growth of the plant which I shall mention. Early one summer morning, I observed a whiteness, like hoar-frost, between the rows of young turnips before their leaves had met across the drills. Knowing from the temperature of the air that the phenomenon could not be hoar-frost, I examined it particularly, and found that it arose from the deposition of dew on in-

numerable minute fibres interlacing one another, proceeding from the roots of the turnips, on both sides, which had not yet attained the form of a bulb. A similar appearance may be observed when a spider's web becomes visible with dew or mist on a furze bush. Having traced these delicately minute fibres to the roots of the plants, by means of the dew, it occurred to me to be an error in practice to work in the turnip land after the development of those fibres, as there is no doubt that these are sent out for a special purpose connected with the growth of the plants. The setting up should either be concluded before these fibres begin to grow, or be abandoned altogether; and I apprehend more injury will accrue to the crop from disruption of those fibres than from want of a channel to carry off superfluous surface-water from even undrained land: for, as to drained ground, such channels are of no use, there being no surface-water to *run off*, the rain being absorbed by the soil as fast as it falls. The fibres are not to be seen after the dew has evaporated, except on the most careful examination of the surface of the soil. The same phenomenon may be partially observed amongst potatoes; but the fibres from their roots spread more under the immediate surface of the ground than those from the turnip. Such is the desire of most farmers to set up the drills, that I have seen the double mould-board plough smashing the leaves of the potatoes and turnips after they had completely met across the drills. On rather strong undrained land it is prudent to set up turnips with the double mould-board plough, fig. 209, in case of the occurrence of a wet autumn, otherwise it is better to omit the operation.

3278. The weeds most troublesome in the turnip-ground are the common couch-grass, *Triticum repens*; the wild mustard, *Sinapis arvensis*; knot grass, *Polygonum aviculare*; wild radish, *Raphanus raphanistrum*, and a few others. Of these the couch-grass is most troublesome while singling the turnips; as, in removing it, its ramifying underground shoots, intertwining the young roots of the turnips, frequently bring away the plants with them. This weed should, if possible, be entirely removed from the ground before the turnip seed is sown. The knot-grass, having

a cluster of small bulbs for its root, when they are removed a large hole is left in their place, and several plants may be brought away along with them. This weed should also be removed as completely as possible before the crop is sown. The wild mustard becomes troublesome on account of its great numbers, covering almost the surface of the ground with its bright yellow flowers; but it is chiefly in the neighbourhood of towns that it appears to so great an extent, from the use, it is said, of the police manure. When allowed to stand so long as to produce flowers—and it is a plant which runs very rapidly through its courses—its stem is difficult to cut with the hoe; and if any plant removed by the roots has attachment to the soil by even a single fibre, it will flourish as if it had never been disturbed. Appearing only with the crop, this weed cannot be removed from the soil before the turnips are sown. The wild radish, though not plentiful, is difficult to eradicate by the toughness of its stem, and the vitality of its roots. It also only appears after the crop is above ground. The red shank, *Polygonum amphitrum*, is difficult to cut with the hoe. Whatever be the weed, it should be entirely severed from the ground. Weeding cannot be practised in singling the crop, as the entire attention must be directed to the single plant to be preserved, although every weed in the way has a chance to be removed. Weeding is professedly practised in hoeing the crop, and it is in the first hoeing that the most effectual manual weeding is given, the second hoeing being chiefly required to stir the surface of the soil around the plants. The scuffler and drill harrow are powerful means of removing the weeds between the rows of plants.

3279. The land should be made quite clean before sowing the turnip crop; but when it has been allowed to run excessively foul to weeds, rather than be too late in sowing the crop by cleaning the land, and rendering it too fine, that is, *deaf*, (356,) *sow the crop in its proper time*; and provided the weeds, chiefly the couch-grass, can be kept down by the horse and hand hoe, until the luxuriance of the leaves cover the drills, the weeds will be smothered under them and rot, and serve partly to support the crop; and after the turnips have been eaten off by the sheep in winter,

not a single weed will be seen in spring when the land is ploughed up for spring wheat or barley. I had a favourable opportunity of witnessing, one season, a corroboration of what I am now recommending. I had a field of 25 acres so foul of couch-grass, that it was utterly impossible to clean it in time. After removing the roughest part of the wrack to a compost, the land was dunged and sown with white globe turnips, and the result was precisely what I have stated above. I may mention that the turnip sowing-machine, which has movable coulters and handles, is the best adapted for sowing foul land, the coulters passing over the larger masses of weeds instead of displacing them.

3280. In conclusion of the turnip culture, after all the manual operations of it are finished, the surface between the rows of turnips should be levelled with the drill-grubber, fig. 264. This operation should be concluded some time in August, and, at all events, before the commencement of harvest, let that be ever so early. The crop requires no farther attention, until the season arrives for pulling and storing the turnips at the commencement of winter, and these I have fully explained from (808) to (834.)

3281. From (383) to (433) I have given a list of plants regarded as weeds that infest the different kinds of soils, and which indicate to a certainty the nature of the soil upon which they grow. Such of those plants as are grasses, and occur as a constituent of natural pasture, are useful, and should be encouraged; but wherever they occur in cultivated arable soil, they are doubtless weeds and should be eradicated. What seems to me a good definition of a *weed* is—when any plant is found growing where it should not be, it is a weed. For example, a stalk of wheat in a bed of tulips in a garden is a weed, and would be removed, and, in like manner, a tulip in a wheat field is a weed, and should be eradicated. When you consider the number of the plants mentioned in the paragraphs above referred to,—and the number is not intended to include all that occurs as weeds in the fields, but only as those decidedly indicative of the nature of the soil upon which they respectively

grow, and when you consider that they all are *weeds* in cultivated fields, in the sense of the above definition,—you may imagine how actively the farmer should be employed in extirpating them in the season they present themselves in the greatest activity. The entire number of them do not make their appearance simultaneously, since each has its season of efflorescence and maturity; and were one allowed to grow, until another was ready to be removed, such is the vigour of growth in wild plants, that the former would shed its seeds and soon occupy the ground to the exclusion of the cultivated plants. The farmer should allow them no such indulgence, and their intrusive tendencies should be checked betimes. Partly for this purpose the land is ploughed before winter, that the roots and seeds of weeds may be directly destroyed by frost and exposure, and indirectly by other natural atmospherical agents comminuting the soil, so as to render their mechanical removal by the roots comparatively easy. By perseverance, it is quite possible for the farmer to get quit of every weed which propagates itself by the root, although it is impossible to prevent weeds appearing among his crops which originate from seed, many of which are brought from a distance by the wind; and it is quite possible, even as regards these, to prevent their maturing the flower and seed. In summer, weeds thrive in the greatest luxuriance, and summer ought to be the season for the farmer to employ his most active means for their destruction. A principle affects the vitality of weeds, which should never be lost sight of in attempting their destruction; and he who practises it will infallibly prevent their coming to maturity. It is a well-known law of vegetation, that the elaboration of the sap is effected by the leaves of a plant, and it is the elaborated sap which enables it to sustain its existence. By preventing the development of the leaves, and consequently the elaboration of the sap, the life of the plant will be sacrificed. The simple plan, therefore, of destroying all sorts of weeds, is to deprive them of their leaves as soon as they appear.

3282. After all the manual and imple-
mental operations in connexion with the

culture of the turnip have been finished, and while the leaves of the plants are expanding, and especially if there appear anything like a cessation in their growth, it is of importance, in the first cloudy or moist weather—and if such do not occur, dewy mornings and evenings—to administer a slight sprinkling, by hand, of guano around each plant, from $1\frac{1}{2}$ to 2 cwt. to the acre. The women workers, provided with coarse aprons, will do this well by the hand, and an apron will contain as much as will suffice for a long drill, going and coming to the headridge, where the cart with the guano should be. Let the women each take a drill, and then no drill or plant will be missed, nor any one receive more than its due allowance of the manure.

3283. The turnip belongs to the order *Tetradynamia Siliquosa* of Linnaeus; to the natural order of *Cruciferae* in the system of Jussieu, from the cruciate form of its petals; and to the *Hypogynous Erogenae*—alliance 27, *Cistalis*—order 123, *Brassicaceae*—division 3, *Orthoploceae*—sub-division *Brassicidae*—genus *Brassica*, of the natural system of Lindley.

3284. *Cruciferae*.—The crucifers are a very natural and important family of plants, and, if we regard their geographical distribution, we shall see that the temperate zone is their favoured region, according to De Candolle:—

	Species.
In the frigid zone of the northern hemisphere	205
In all the tropics (and chiefly in the mountainous regions)	30
In the temperate { of the northern hemisphere, 548 } zone	634
{ of the southern hemisphere, 86 }	

According to Humboldt's statistics of the principal families of plants, it would also appear that the crucifers have the maximum of their species in the temperate zone, and decrease as well toward the equator as toward the poles. They are almost unknown in the torrid zone, if we consider the mountain regions between 7,670 and 10,870 feet in height, where these plants scarcely form one eight-hundredth of all the phanægomous plants. In the temperate zone their quotient in Europe is one-eighteenth; in America only one-sixtieth; in the frigid zone one-twenty-fourth. The scarcity of this family in the temperate zone of America is a remarkable circumstance. Schouw, in his botanical division of the globe into 25 phytogeographical regions, places the crucifers in the second, wherein they extend over northern Europe and Asia from the southern limits of the first region to the Pyrenees, the Alps, the Balkan mountains, the Caucasus, and the Altai, within the mean temperature of 36° to 57°.*

* Johnston's *Physical Atlas*—Phytology, Map No. 1.

3285. "The universal character of crucifers," says Lindley, "is to possess antiscorbutic and stimulant qualities, combined with an acrid flavour. The officinal species are among the commonest of all plants, and only require to be named. They are found to contain a great deal of nitrogen, to which it is supposed is due their animal odour when rotting. . . . When the acrid flavour is dispersed among an abundance of mucilage, various parts of these plants become a wholesome food, such as the root of the radish and the turnip, the herbage of the water-cress, the cabbage, and the sea-kale. According to Müller, the water-cress contains iodine. Sulphur exists in the oils of mustard and horse-radish to the extent of about 30 per cent. The oil from their seeds is one of their more important products. That from rape is in very general use, and the residue, rich in nitrogen, is largely employed by the farmer as manure or cattle-food, under the name of oil-cake," (rape-cake it should be, oil-cake being obtained from linseed.) "Another of the oil plants is *Camelina sativa*, or gold of pleasure; but its cake is said to be too acrid for cattle; brooms are made from the dry haulm."*

3286. The Swedish turnip is named by botanists *Brassica campestris, rutabaga*, and its specific characters are, according to Don, "leaves rather fleshy, covered with glaucous bloom; first ones rather hispid or ciliated, lyrate, toothed; the rest cordate, stem clasping, acuminate, partly pennatifid; is a native of Britain, Lapland, Spain, Transylvania, and in the Crimea in fields.

3287. "The common turnip is the *Brassica rapa*, having the radical leaves lyrate, destitute of glaucous bloom, green, covered with bristly hairs, middle cauline ones cut, upper ones entire, smooth. Native throughout Europe in cultivated fields, and their borders."†

3288. After a gravelly knoll of about 30 feet in height had been cut through, in forming the railway from Belfast to Lisburn, I observed a large number of wild turnip plants growing on the sides of the embankment, formed by wheeling the gravel from the knoll. The leaves of all the plants were beautifully expanded, of a dark green colour, and quite healthy, but not even the rudiment of a bulb was forming.

3289. The waste of turnip-seed, by the time the turnips are singled, is surprising. From 2½ lb. to 3 lb. of seed is sown in the acre, and as in (877) 25,813 plants of white globes at 9 inches apart; 23,232 of yellows, at 10 inches apart; and 19,360 of swedes, at 12 inches apart, can grow on an acre on drills at 27 inches asunder; and as 1387 seeds of swedes, 1645 of purple top yellows, and 1800 of white globes, weigh one drachm, it follows that 1 oz. 6 drachms of seed of troy, or 14 drachms of avoirdupois weight, are sufficient for the above crops; so that the waste in turnip-seed is as 27 to 1. It is a remarkable fact that the respective weight of the seed of those tur-

nips bears the same proportion to the respective distances of the bulbs in the drill, so as to make the waste of seed in each 27 to 1. It must not be supposed, from these results, that 1 oz. 6 drachms troy of turnip seed will suffice to sow an acre, for many of the seeds may want vitality, and many others, in sowing, are no doubt buried too deep to vegetate with the rest. Abundance of turnip-seed not only secures a full braird, and tends to draw the plant quickly to a state for being singled, but quickness, combined with abundance, of growth, is the best safeguard against the injurious attacks of insects.

2390. *Turnip Flea-beetle*.—The insect which first infests the turnip-plant, and attacks its seed-leaves, is the turnip flea-beetle, *Haltica nemorum*, fig. 268, usually,

Fig. 268.



TURNIPI FLEA-BEETLE
—HALTICA NEMORUM.

though improperly, designated the turnip-fly, which is a very different sort of insect. The flea-beetle is a coleopterous or hard-shelled insect, capable of either penetrating the ground or of bearing a considerable pressure. "It is a small insect," says Mr Duncan, "scarcely one-eighth of an inch in length. It is smooth, shining, and of a brassy black colour, with a slight tinge of green, particularly on the wing-cases; the antennæ black, with the second and third joints, and the apex of the first, of a pale colour. The thorax is convex above, and pretty deeply punctured; the wing-cases are much wider than the thorax, likewise thickly and irregularly punctured, each of them with a pale yellow or slightly sulphur-coloured stripe running along the middle, curved inwards posteriorly, and not reaching quite to the extremity; the under side of the body and thighs black; all the tibiae and tarsi of a pale hue. This little insect feeds on the turnip, which it attacks both in its perfect and larva state. When the plants have acquired some degree of strength, and the foliage is considerably developed, the injury done by it is insignificant; but unfortunately its favourite food is the young plant, just as it is beginning to unfold its cotyledon leaves. These it consumes with the utmost avidity, both as a larva and full-grown insect; and when it abounds, the field is often wholly stripped of its crop in a very short time. Indeed their powers of mastication are surprising for creatures of such small size. An individual who confined a few, for the purpose of observing their habits, found that they consumed 10 young turnip-plants every day. This may serve to give an idea of the extent of their devastations when their numbers become excessive. They are found to attack the turnip plants as soon as the latter make their appearance; and one of the difficult points to determine is, how they are produced so speedily and so opportunely. In regard to the turnip saw-fly, and lepidopterous

* Lindley's *Vegetable Kingdom*, p. 353.

† Don's *General System of Botany and Gardening*, vol. i. p. 242-5.

insects, the process is obvious, the eggs being laid upon the plant by the parent fly, and the larvæ evolved more or less speedily, but after the lapse of some considerable time. The appearance of the plant and insect being in the present case almost simultaneous, it has been thought difficult to conceive how the same process should be gone through.* Various conjectures have been formed to account for the early appearance of this insect on the turnip-plant. "But these conjectures," continues Mr Duncan, "may now be referred to merely as matters connected with the past history of this insect, and as showing the difficulty that has been experienced in tracing it throughout its different forms and changes. This, however, has been recently done by Mr H. Le Keux, and we are no longer in doubt as to the points alluded to. This observer found that the sexes pair from April to September, during which period the eggs are deposited on the under side of the rough leaves of the turnip. The female insect apparently does not lay above one egg daily—in a week, ten pair were found to lay only forty-three eggs. These eggs are very minute, smooth, and partaking of the colour of the leaf. They are hatched in ten days, and the maggots, fig. 269, an

Fig. 269.



LARVA OF THE FLEA-BEETLE.

eighth of an inch long, are pale, fleshy, and cylindrical, with six pectoral feet, the eyes dark, and a dark patch on the first and last segments of the body; immediately eat through the lower skin or cuticle of the leaf, and form winding burrows among the pulp, upon which they feed. The thickness of the leaf is sufficient to afford them ample scope for this, and they may be seen at work in their galleries by holding the leaf up to the light. These maggots or larvæ are full-fed in 16 days, when they bury themselves in the earth not quite 2 inches below the surface, selecting a spot near the bulb, where the turnip-leaves protect them from wet and drought. They enter upon their chrysalid state in the earth, and the beetle emerges in about a fortnight. About thirty days carry the insect through all its different stages; and of these, ten are passed in the egg state, six as a maggot, and fourteen in the chrysalis. There appear to be 5 or 6 broods in the season.†

3291. In the case of those insects which feed on the foliage of plants in their larva state, and afterwards derive their aliment from other substances, the general law seems to be, that a much longer duration is assigned to the larva than to the perfect insect; and it may be that this is not observed in regard to such as always consume vegetables, because in either of these conditions they serve the same purposes in the economy of nature, to which the prolonged existence of the larvæ bears reference in the

other instance. Parallel examples are of frequent occurrence, amongst insects. Unless the eggs of the common flesh-fly were hatched with extreme rapidity, the larvæ, when they appear, would neither obtain their food in perfection, nor fulfil the useful purposes for which they are now subservient.

3292. The remedies against the attacks of this insect are, I fear, of a hopeless character; at least, it is better to prevent their appearance than wage war against them when they do appear, as, even in the efforts to effect their destruction, the farmer is the chief sufferer. The preventive measures seem to be to keep the land in as clean a state as possible of all weeds, and especially of those of the cruciferous kind, such as wild mustard and charlock, which are the special favourites of this beetle; to sow the turnips in drills instead of broad-cast; but whether it is this difference in the culture of the crop which makes it less vulnerable, I do not know, although the attacks of the turnip insects, being less frequent in Scotland than in England, would lead the mind to such a conclusion; to sow the seed thick and of the same age, for it is found that the more rapidly the plants grow at first, they are the less often attacked; to put the seed for some time before it is sown amongst flour of sulphur, and sow the sulphur amongst it. The late Mr Airth informed me, that when he farmed the Mains of Dun, Forfarshire, his young turnip crops were often very much affected, and even destroyed, by these insects, but after using the sulphur, he never suffered loss—though his neighbours did, who would not use the same precaution—for the eighteen years he possessed the farm. It may be that the juices of the plant are so affected by the sulphur as to cause disrelish for it, while the disagreeable odour arising from the sulphur strewed in the soil may drive the insect away. The sulphur was found in no degree to injure the vegetative powers either of seed or of plant. Being a simple preventive, it is worth trying by those whose crops are usually affected by insects.

3293. As a remedial measure, a long-haired hearth-brush switched along the drills by field-workers would cause the insects to fall from the plants better than any board or net; and if quicklime were strewed immediately upon the plants, as recommended from the experience of 102 practical farmers of the Doncaster Agricultural Association, their destruction would likely be more certain.‡

3294. *Turnip Saw-fly*.—The insect which commits the greatest ravages on the turnip crop, after the one just described, is the turnip saw-fly, *Athalia spinarum*, fig. 270. It belongs to the order Hymenoptera, having 4 membranous wings, and it is denominated a saw-fly from the

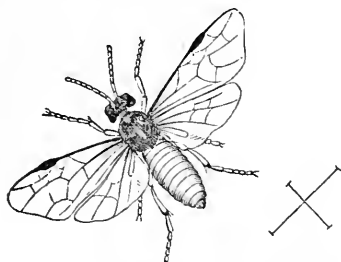
* Quarterly Journal of Agriculture, vol. viii. p. 353.

† Transactions of the Entomological Society of London, vol. ii. p. 24.

‡ Report of the Doncaster Agricultural Association on the Turnip-fly, 1834. A fuller account of the *Haltica nemorum*, by Mr Curtis, will be found in the Journal of the English Agricultural Society, vol. ii., p. 193-213.

use and appearance of the instrument with which it deposits its eggs. It is placed at the extremity of the abdomen of the female on the under side: and is so constructed, that it combines the

Fig. 270.



THE TURNIP SAW-FLY—ATHALIA SPINARUM.

properties of a saw and auger. It is distinguished by the following characters:—"Head wider than long; deep black, with three ocelli in the centre; eyes oval; antenna black above, and for the most part dull yellow beneath; labrum and pulpi, light yellow; thorax, black above, with a triangular space in front; the scutellum and a spot behind it, reddish orange; the collar, which is rather long and slender, black on the sides, and yellow in the middle; abdomen rather short, entirely orange-yellow, inclining to red, with a small black spot on each side of the first segment; legs likewise orange-yellow, the tarsi paler, approaching to whitish; the tip of the tibiae, and of each of the tarsal joints, black; the tibiae with two spines at the apex, and the joints of the tarsus each with a very slender lobe beneath; extremity of the ovipositor, black; wings yellowish at the base; the costa and stigma black. Length, 3 to 3½ lines, exclusive of the antennae. *Antennae*, short, and somewhat club-shaped, 9 or 10-jointed in the male, but generally with the appearance of 11 joints in the female, the radial joint slightly thickened at the extremity, the second shorter and ovate, the third, as long, or longer, than any two of the other joints taken together, the remainder decreasing somewhat in length to the terminal one, which is large and ovate.

3295. "The flies which appear in the early part of summer, and deposit their eggs on the young turnip plants, have probably survived the winter under ground in the pupal state, enveloped in their cocoon. Emerging from them as soon as the milder weather is confirmed, in their winged state, the females immediately lay their eggs, after which they very soon die. The eggs appear for the most part to be placed round the outer margin of the rough leaves. In favourable weather they are hatched in a short time, and the young larvæ immediately commence their attack on the plant. At first these larvæ are of a deep black colour, and, of course, small size; but they grow rapidly, and in the course of a few weeks attain their full dimensions. In the course of their growth, they change their skin

several times, and most of these moultings are attended with a slight change in the colour. After casting their last skin, they are of a dark lead or slate-gray colour, paler beneath. Mr Curtis states that they are sometimes green, a colour which we never saw them assume, for in general they are not liable to much variation in this respect. Like most of the other larvæ of their tribe, when touched, or in any way disturbed, they coil themselves up, and remain motionless. . . . When full grown, the larvæ cease to eat, and allow themselves to drop from the plant that nourished them to the ground, in which they usually bury themselves, or they take shelter among rotten leaves, moss, &c. When examined after a short time, they are found to be completely enclosed in a cocoon, composed of two distinct layers of silk. The inner layer is of a fine satiny lustre, and when the cocoon is opened, it appears as if it had been washed with a solution of silver. When the fly is fully matured, it makes its exit by gnawing with its mandibles a hole in one end. The larvæ are known in different parts of the country by the names of *black caterpillar*, *blacks*, *niggers*, *canker*, &c.

3296. "The loss they occasion to farmers is very considerable, but data cannot be easily obtained to form an estimate of its amount. In some instances the crop is wholly destroyed, and where the caterpillars are most numerous, the injury they occasion to the plant appears in the diminished size of the bulb, its vegetative functions being impeded by the partial consumption of the leaves. A belief at one time pretty generally prevailed that they did not attack the Swedish turnip, and they certainly seem less partial to that plant; for, examining a field in which swedes alternated with the ordinary kind, the caterpillar was found much less plentiful in the former, and in many places did not appear at all. The late Earl of Leicester, however, lost in 1836 upwards of 200 acres of swedes by them, and that plant by no means escaped in other parts of the country. They are said to have attacked the mangold wurzel, but this seems not at all probable." My own turnips never suffered from insects but in one season, when the swedes were partially attacked by this saw-fly after they were singled. The leaves were eaten to the stem, and the crop seemed as if it would be lost, but it recovered and produced a fair one after all.

3297. "Unfortunately," adds Mr Duncan, "it is more easy to describe their depredations than to suggest an efficient remedy of easy application. A distinguished delineator of insects, who has published a beautiful figure of the fly, expresses his belief that it is not difficult to destroy them, 'for if they were brushed off the leaves, it seems they are unable to crawl upon the ground and recover their station; they consequently perish unless they are full-grown at the time; but as there is a constant succession from August till near November, the operation of drawing a hurdle or board over the turnips ought to be repeated at intervals during that period.'"* Of

* Curtis's *British Entomology*, vol. xiii. folio 617

course, this method can be effectual only on the supposition that the caterpillar is unable to crawl; it might have been presumed, however, that it did not receive such a complement of legs merely as a matter of form, and accordingly the slightest observation shows that it can move about with facility.* Rain will destroy the caterpillars; ducks are very fond of them. I have often thought that women and boys might be employed to whisk them off the plants, and though they would not thereby be destroyed, they would be much annoyed, and, during the time the annoyances were repeated, the crop might advance as far as to escape serious injury. The most effectual destruction would be that of the fly itself before it lays its eggs. It is very sluggish in its flight, does not fly far at a time, and may be easily caught by hand, or with an entomologist's net. Swallows are useful assistants in capturing these flies. Each fly so destroyed would prevent the coming into life of from 250 to 300 caterpillars. It has been ascertained that a boy of ten years of age can gather 180 caterpillars in an hour; and a troop of young ducks, preceded by a boy or girl to switch them to the ground, would destroy them in great numbers. Young fowls are also efficacious, but old ducks and old fowls do not work well.

3298. *Caterpillars*.—As the term caterpillar is so frequently used in reference to insects, it is right to be able to distinguish between *true* and *false caterpillars*. The larvæ of the saw-fly are called *false caterpillars*, from the general resemblance they bear to the larvæ of butterflies and moths, to which the name of, caterpillar is properly applied. A very slight examination, however, soon shows decided marks of distinction. Caterpillars, *properly so called*, have never more than 16 feet, while the larvæ of saw-flies have generally from 18 to 22; a few have only 6—a circumstance which again distinguishes them from true caterpillars, in which the number of these organs is never below 10. Another mark of distinction is afforded by the structure of the feet. In lepidopterous larvæ, the abdominal legs are surmounted by a coronet of small hooks, which is never found to be the case in those of false caterpillars, as they are simple mammiform protuberances. This minute difference, which can only be detected by the microscope, has, however, a material influence over their habits, and often enables us to distinguish between the respective kinds at first sight. The coronet of hooks converts the membranous or abdominal legs of caterpillars into efficient instruments of prehension, and they accordingly fix their body by means of them to the place of position, while the head and anterior part remain free. The abdominal legs of the others, on the contrary, are mere points of support, incapable of clinging to an object, and the larvæ consequently fixes itself by its pectoral or fore-legs, which are much developed for the purpose. The whole of the

abdominal portion of the body is thus left at liberty, and it is either borne curved inwards, as in the gooseberry saw-fly, *Nematus grossulariæ*, or projects into the air in variously-contorted and singular postures, as is remarkably the case with the willow saw-fly, *Nematus carycæ*, and the larvæ of *Hylotoma rosæ*, the rose saw-fly, which has the extremity of its body almost always raised and curved in the form of the letter S. Additional distinctive characters might be mentioned—such as the form of the eyes, which are pretty large in the false caterpillars, and placed one in each side of the head; while in true caterpillars they are small, almost invisible points, disposed in a circle. These peculiarities will suffice to distinguish the two tribes, and it is of importance to be able to do so, as they are often associated together in the work of destruction. The body of false caterpillars is generally composed of 12 segments, but the incisures are distinctly defined, and liable to be confounded with the transverse wrinkles which thickly cover the whole surface. Many of them are marked with bright and varied colours, but the majority are of one colour. In this respect they often undergo a remarkable change after they have cast their last skin, the colour becoming entirely unlike what it was before, so that it is impossible to recognise the same individual. This change, indeed, extends even farther than to colour, for such kinds as are furnished with tubercles or spines in their earlier stages, lose them at their last moult, and become smooth; that of the gooseberry species, *Nematus grossulariæ*, for example, loses the black tubercles, which made the surface appear as if chagreened. Like the flies which they produce, these larvæ are sluggish and inactive, seldom moving from the place where they fix themselves, unless when requiring an additional supply of food. When not engaged in feeding, or when apprehensive of danger, most of them roll themselves into a circle, sometimes with the tail elevated in the centre. The greater number lie exposed on the foliage of plants, but others take up their abode in the interior of the slender shoots, and feed on the immature pith; others lodge in the interior of fruit, and cause it speedily to decay.

3299. *Turnip weevils*.—A very small weevil, scarcely one line in length, of a uniform black colour, slightly tinted with metallic blue on the elytra, the latter with punctured lines, the *Ceutorhynchus contractus*, is found occasionally associated with the turnip flea-beetle, *Haltica nemorum*, feeding on the young leaves of that plant. This species does also good by attacking that pestilent weed, the wild mustard, *Sinapis arvensis*. Another species, *Ceutorhynchus pollinarius*, attacks the nettle, *Urtica dioica*, a troublesome weed near buildings; and a third, *Ceutorhynchus assimilis*, occasions the knobs on the roots of the wild radish, *Raphanus raphanistrum*, one of the most troublesome weeds which

* *Quarterly Journal of Agriculture*, vol. vii. p. 562-566. Other accounts of this insect will be found in Kirby and Spence's *Introduction to Entomology*, vol. i. p. 186; *Journal of the Royal English Agricultural Society*, vol. ii. p. 364-389; Newport's *Observations on the Turnip Saw-fly*; and in Newman's *Letters of Rusticus—On Blight*, p. 99.

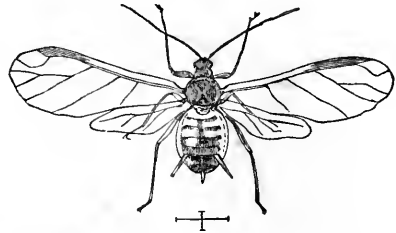
infest cultivated fields, particularly those in which the turnip is cultivated.

3300. *Aphides*.—That multitudinous tribe of insects, named the *Aphis* or plant-louse, sends a few of their number to attack the turnip crop, and their attacks are chiefly directed against the Swedish turnip. Mr Curtis says that there are 3 if not 4 species of aphides which live upon the turnip; one he has found under the rough leaves of the English varieties, as well as one which he believes to be distinct; another appears to be attached to the svedes, and the last is secreted amongst the flower stalks. I cannot enter fully upon this extensive and interesting subject, and must refer you to Mr Curtis' paper.* I shall only add a few words descriptive of the nature and peculiarities of that very curious tribe of insects, the aphides, from another author: "As almost every animal has its peculiar louse, so has almost every plant its peculiar *plant-louse*; and, next to locusts, these are the greatest enemies of the vegetable world, and, like them, are so numerous as to darken the air. The multiplication of these little creatures is infinite, and almost incredible. Providence has endued them with privileges for promoting fecundity, which no other insects possess: at one time of the year they are viviparous, at another oviparous; and what is most remarkable and without parallel, the sexual intercourse of one original pair serves for all the generations which proceed from the female for a whole succeeding year. Reaumur has proved, that in 5 generations, one aphid may be the progenitor of 5,904,000,000 descendants; and it is supposed that in one year there may be 20 generations." Bonnet says there may be 30. "This astonishing fecundity exceeds that of any known animal, and we cannot wonder that a creature so prolific should be proportionably injurious: some species, however, seem to be more so than others. Those that attack wheat, oats, and barley, of which there are more kinds than one, seldom multiply so fast as to be very noxious to those plants; while those which attack pulse spread so rapidly, and take such entire possession, that the crop is greatly injured, and sometimes destroyed by them."† Mr Walker enumerates 6 different states of the aphid—winged oviparous female, wingless oviparous female; winged viviparous female, wingless viviparous female; winged male, and wingless male. The wingless female is the parent of the winged females; the winged female is generally oviparous, while the wingless female is generally viviparous. An oviparous individual never becomes viviparous, nor a viviparous one oviparous.‡

3301. Fig. 271 represents the winged male of the common turnip plant-louse, *Aphis rapæ*, magnified. Its characters are ochraceous, horns moderately long, setaceous, two first joints black, third ochraceous at the base; head blackish; collar ochraceous and brown, disc of shining black; abdomen greenish; wings iridescent, the ner-

vures light brown; tips of the thighs, shanks,

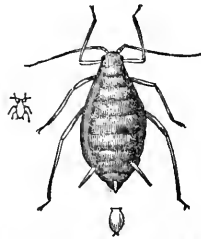
Fig. 271.



WINGED MALE OF THE COMMON TURNIP PLANT-LOUSE—*APHIS RAPÆ*.

feet, and claws, black. Abundant beneath the leaves of the common turnip the whole of July, &c. It is at once distinguished from the other species by its long tubes and small apical cells of the wings. The cross-

Fig. 272.

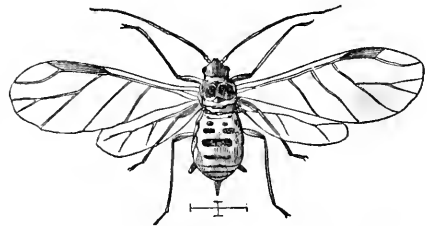


WINGLESS FEMALE OF THE COMMON TURNIP PLANT-LOUSE—*APHIS RAPÆ*.

ed lines below represent the natural size of the body and of the expanse of the wings. Fig. 272 is the female of the same species magnified. It is bright green, shagreened; horns fuscous, except at the base; eyes, tips of shanks, and feet, black. The small figure on the left represents the aphid of the natural size, and the figure below represents one of the natural size just excluded.

3302. Fig. 273 is the winged male of the aphid which infests the Swedish turnip and cabbage

Fig. 273.



WINGED MALE OF THE SWEDISH PLANT-LOUSE—*APHIS BRASSICÆ*.

plants, the *Aphis brassicæ*, magnified, the lines below representing the natural size of body and expanse of wings. Generally pea-green; horns setaceous, longish and black, as well as the head, collar, and disc of thorax; several blackish bands more or less perfect across the body; tubes short and stoutish, black at the base; wings iridescent, stigma pale green; nervures strong, piceous, apical cell large, and the first furcate one wider

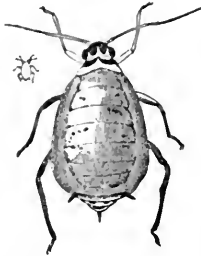
* *Journal of the English Agricultural Society*, vol. iii. p. 49-56.

† Kirby and Spence's *Introduction to Entomology*, vol. i. p. 174.

‡ Newman's *Letters of Rusticus—On Blight*, p. 68.

than the species above; legs black, base of thighs green. Fig. 274 is the female of the species.

Fig. 274.



WINGLESS FEMALE OF THE
SWEDE PLANT-LOUSE—
APHIS BRASSICÆ.

and black, as well as the legs; base of thighs greenish. The small figure on the left represents this aphid of the natural size. "As far as my observation goes," says Mr Curtis, "the swedes have suffered most from the aphides; the under sides of the curled leaves being sometimes densely covered with them of all sizes. The old wingless females are seen resting in August, September, and October, surrounded by their young broods, with here and there a winged male walking lazily over his kindred. The leaves are frequently, at the same time, gray with mildew; but that is a distinct disease. It is said that, in a very dry autumn, early sown turnips seldom escape the mildew, which is a species of fungus forming a whitish powder over the leaves, and readily brushing off. The leaves thus affected soon become yellow, dry, and brittle; and, at an early stage, this disease seems to encourage the aphides, owing to the plants not being healthy and able to resist such attacks. I may observe that I have seen myriads of *Aphis brassicæ* under cabbage leaves in July, and secreted in the leaves of the crumpled broccoli as late as the end of November, when they were of all ages and sizes, both winged and apterous."

3303. *Honey-dew*.—"Whether any of the above aphides deposit the sweet liquor called honey-dew upon the turnip leaves," remarks Mr Curtis, "has not yet been observed; but I have never seen the ants occupied in visiting the infested leaves for the purpose of collecting the saccharine matter which exudes from the two abdominal tubes or ducts, and which is also discharged from the extremity of the bodies of some species. The exudation of this honey, which passes off through the tubes, and crystallises in cold weather, may be a necessary means of disposing of any surplus secretions arising from the constant supply of sap which is passing through the stomachs of these little leeches, and which they may not have the power of discharging fast enough by the usual organs."

3304. A writer assuming the name of Rustiens says—"I am quite convinced that honey-dew is

a secretion from the aphides, and that ants devour this honey-dew, and a sweet, clear, liquid honey it is. I have often watched an ant go from one aphid to another, stand behind each, and gently squeeze the body with its fore legs; perhaps one aphid in ten, not more, will give out a small drop of honey, as clear as crystal, which the ants instantly swallow. The ants take much more care of the aphides than the aphides do of themselves: they are sad, dull, stupid creatures. It is very pretty to see the licking and washing, and cleansing, and caressing which the ants constantly bestow on them.*"

3305. "Protected as the aphides are in the wrinkles of the leaves, which they themselves have caused by the pumping up and extravasation of the sap, it is, I think," observes Mr Curtis, "impossible, in the open field, to apply any effectual remedy for the extirpation of this prolific tribe. When it is in our power, the best plan would be to cut off the diseased leaves as soon as the presence of the insects is detected, and crush them completely under foot; or put them into a sack, and carry them away to be destroyed with boiling water."

3306. *Lady-birds*.—"Fortunately, no tribe of insects has a greater number of natural enemies to keep it in check than the plant-lice. One of the most conspicuous and efficient enemies are the *Coccinelle*, of which about 30 different species have been noticed in England. Lady-birds pass the winter in the crevices of palings and trunks of trees, &c., and are ready to come out with the

Fig. 275.



TWO AND SEVEN SPOTTED
LADY-BIRDS—COCCINELLA
BI ET SEPTEMPUNCTATA.

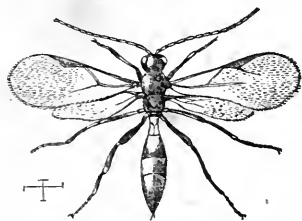
slightest increase of heat in spring. They eat into the side of the aphid, and thus destroy many daily. The two most common species are the *Coccinella bipunctata*, two-spotted lady-bird—a small insect of $2\frac{1}{2}$ lines long, in fig. 275 a; and a larger one, *Coccinella septempunctata*, seven-spotted lady-bird, which is $3\frac{1}{2}$ lines long, and nearly 3 broad, fig. 273 b; both of the natural size.

3307. *Ichneumon fly*.—Another active enemy of the aphid is the ichneumon fly, *Aphidius rapæ* of Curtis, fig. 276, magnified. Antennæ shorter than the body, composed of 14 joints; basal joint beneath, as well as the mouth, ochraceous; head and thorax shining black; abdomen spindle-shaped and pitchy in colour, attached to the trunk by a narrow ochraceous pedicel; wings four, iridescent, superior, with a narrow fuscous stigma, from which issues, beneath, a short curved nervure, and there is a large elongate trigonate cell at the base: legs six, slender, and bright ochreous, variegated with dark brown; length $1\frac{1}{2}$ line, expanse of wings $2\frac{1}{2}$. The small cross lines at the left side represent the natural size of the fly with the wings expanded. This fly

* Newman's *Letters of Rusticus—On Blight*, p. 108.

hovers about plants infested by the aphid, and the female soon fixes on a female aphid, pierces her

Fig. 276.



ICHNEUMON FLY—APHIDIUS RAPE.

with her ovipositor, laying a single egg, and then proceeds to another, and thus inoculates a considerable number. As the aphid imbibes the juice of the plant, the little maggot which has hatched in her body hourly increases in size, until the exhausted aphid dies. As there are many generations of ichneumon flies in a summer, it follows that they are most formidable enemies to the plant-lice.

3308. *Turnip-leaf Miners*.—There is a class of insects called *turnip-leaf miners*, the larvae of which destroy the energy of the leaves of turnips, by boring galleries between their upper and under surfaces, in the manner which is now ascertained to be the case with the turnip flea-beetle. One is the *Drosophila flava*, which forms its dwellings so carefully under the upper cuticle of the leaves that not a trace of them can be seen on the under side. Its length is 1 line. The larva of this insect is destroyed by two little parasitic hymenopterous flies, the *Ceraphron niger*, and the *Microgaster viridis*. The other leaf-miner is named *Phytomyza nigricornis*, which is bred from the under sides of the turnip leaves, where the maggots form long irregular galleries inside of the lower cuticle, and these miners are not visible on the upper side of the leaf. The fly is 1 line in length.

3309. *Moths*.—Lepidopterous insects, that is, those of the butterfly and moth kind, afford several species injurious to the turnip crop. One is the turnip diamond-back moth, *Cerostoma xylostellata*. When at rest the wings are closed and deflexed, and the horns are projected forward in a straight line. It is more or less brown. The upper wings are long and narrow, and when closed form 2 or 3 diamonds upon the back; the inferior wings are lance-shaped, and of an ash-colour, with a very long fringe. Its length is $2\frac{1}{2}$ lines. The caterpillar is green, about half an inch in length, slender and tapering to both ends. They are exceedingly active, and on the slightest touch wriggle themselves off the leaf they are feeding, and let themselves down by a silken thread, and remain suspended until the cause of alarm subsides. As many as 240 have been counted on one leaf, and such is their avidity, that not the smallest vestige of a green leaf is left by them. This larva is destroyed by a black ichneumon, named *Campoplex paniceus*.* The cabbage-moth, *Manestra brassicae*, will live on the Swedish turnip. The forelegs are ash-brown, clouded with ash-gray

streaked across with black; they have a mark resembling the letter W on the disc of the anterior wings, which expand $1\frac{1}{2}$ inch. The caterpillar is greenish or brownish, with a dark stripe along the back, on which a pale line is visible; the sides are marked with an obscure yellowish stripe, having a tendency to become reddish on the upper side. The spiracles are white surrounded with black. The White line brown-eyed moth, *Manestra oleracea*, is of a rusty-brown colour, the fore-wings at times slightly clouded, the cross-lines obliterated. The caterpillar reddish or yellowish-brown, with a dark line along the back, and another on each side, and beneath the latter a white line; underside and feet light-brown. The Gamma or Y-moth, *Plusia gamma*, is easily recognised by the silvery character on its fore-wings resembling the letter Y, or rather the Greek γ , upon a variegated dusky-brown ground. Head and thorax ash-gray; the abdomen of a lighter hue. It expands from $1\frac{1}{2}$ to $1\frac{3}{4}$ inch. The eggs of this moth are very beautiful, being of an orbicular shape, with elevated ribs, and slender, transverse, raised lines. They are chiefly laid on the under side of leaves, sometimes singly, but more commonly in small clusters. When the caterpillars reach maturity, they are green, with 6 white or black lines along the back, and a faint yellow streak on each side; the breathing pores black. They possess only 4 abdominal feet, and 2 anal ones, thus indicating an approach to the geometric or looper caterpillars. The chrysalis, which is pitchy-brown, is inclosed in a white woolly cocoon, spun between the folds of a leaf, or among herbage. The moth flies about in the day with much rapidity, keeping the wings, when feeding, in constant vibration. They may be seen, often in great numbers, hovering in this manner about a turnip-field, over the yellow blossom of the charlock and field-mustard, or the blue heads of the scabies and devil's-bit.† There is no moth more shy and difficult to catch by day, for it will seldom allow any one to come near it, but whether it detects the approach of man by its eyes, which sparkle like living rubies, or by its hearing, is not known: it darts off, however, in an instant, when disturbed, and stops again a few yards off, or entirely vanishes. There is, perhaps, nothing but hand-picking, or switching the turnip-plant, to get quit of these insects. The Large White cabbage butterfly, *Pontia brassicae*, lays eggs in clusters, of 20 or 30, on the under side of the turnip leaves. The caterpillars are green before and yellow behind, when young, but, when matured to full growth, are $1\frac{1}{2}$ inch long, and as thick as a small goose-quill. They chiefly attack the Swedish turnip. They are destroyed by the ichneumons *Microgaster glomeratus* and *Pimpla instigator*, and by the cynipis *Pteronatus brassicae* and *pontia*. The Small White or turnip butterfly, *Pontia rapae*, as its name implies, is another enemy to the turnip. The superior wings of the male are tipped with black, and the inferior have a black spot on the upper edge; the female is similar, but has 2 large black spots likewise beyond the centre of the superior wings;

* *Journal of the English Agricultural Society*, vol. iii. p. 62-72.

† *Quarterly Journal of Agriculture*, vol. xiii. p. 167-170.

underside of the same white, apex yellow, and 2 black spots beyond the middle, the lower one sometimes obliterated; inferior wings yellow, freckled with black. Length of male 8 lines, and expanse of wings 2 inches. The eggs are not unlike those of the cabbage-butterfly; but the caterpillar is totally different, being entirely green, and so densely clothed with minute hairs, as to be velvety. They have a yellowish stripe down the back, and another along each side. They are more than 1 inch long, and about as thick as a crow quill. The small oval eggs so deeply embedded in the pulpy substance of the back of some turnip leaves, are laid by the *Chrysomela betule*, a brilliant shining or green oval beetle, with undersides, horns, and legs black, and about $1\frac{1}{2}$ line long.

3310. Besides the leaves, the turnip is attacked by insects in the bulb, among which noxious insects are many large caterpillars, called by farmers and gardeners *surface grubs*, which commit very extensive depredations upon turnips. Among these is the caterpillar of the *Triphaena pronuba*, the Great yellow underwing. This moth is sometimes very plentiful in hay-fields, where it will rise from the swathes when disturbed, and alight again in another swathe. The *Noctua* or *Agrotis exclamatoris*, the Heart and Dart moth, so named from the markings of the wings resembling the note of exclamation (!), and a heart and a dart, affords a caterpillar of a dull lilac colour, with a lurid space down the back of a more ochreous hue, which is a most destructive animal to crops of turnips at every stage of their growth, it being very apt to separate the crown from the root. The grub of the *Noctua* or *Agrotis segetum* is a very formidable assailant in the more advanced state of the turnip plant, near to which it forms a round hole in a vertical direction about 2 or 3 inches deep in the earth. At the bottom of this it remains during the day, unless it be dark and moist, and at night it emerges from its burrow, and commences an attack upon a plant by eating round the neck of it, and eventually detaching the upper part from the root. In this way singled Swedish turnip-plants may be destroyed one after another until very few are left. The rook is useful in searching for this grub, and in quest of it will also tear up the plant. Young pigs are fond of it, and would dig for it in a turnip-field, were it not that they would dig up the plants at the same time. There seems no ready means of getting quit of this pest. The excrescences which frequently disfigure the turnip bulb, and are not confined to any particular variety of turnip, on being opened will be found to contain a small maggot. This is produced by the *Ceutorhynchus plucrostigma*, the turnip-gall weevil. It is very similar to the turnip-seed weevil, but is black instead of gray; the wing-cases are not so rough or strongly tuberculated at their extremities, and all the thighs have a small tooth beneath. It is not uncommon in hedges from May to August, and, closely contracting all its members when alarmed, it looks like a black seed. The female pierces a hole in the rind of the tur-

nip with her proboscis, and deposits an egg in it; and the young maggot, which is fat and whitish, often of a bright flesh-colour, lives on the substance of the bulb. Except in affecting the beauty and symmetry of the bulb, this insect does no great harm to the turnip.*

3311. A plan of destroying moths in vineyards has been tried by M. Audouin with success, and which consists of lighting lamps covered with bell-glasses smeared with oil, when the light attracts the insects, and they are captured on the glass. Such lights are much more effective than open fires of brushwood. In this way 200 lamps the first night, and 180 the following nights, placed at 25 feet apart, in 4 nights in August 1842, in a vineyard of 4 acres extent, and lighted for 2 hours each night, destroyed these numbers of moths in the respective nights—30,000, 14,400, and the two last nights 9260; in all, 53,660. Of these it was reckoned that three-fourths were females, which, supposing they would have laid 150 eggs each, caused a destruction of 6,000,000 of eggs. Many moths, I apprehend, might have been caught besides, while flickering round the lamps, with an entomologist's net. †

3312. *The Anbury in Turnips*—Mr Marshall, in allusion to the anbury, says that it is a large excrescence produced below the bulb; and when this was just forming, and not larger than a green walnut, the anburies were as large as a goose's egg, irregular in form, with excrescences below, and not unlike raees of ginger depending from them. After arriving at maturity, they exhibit a putrid fermentation, and emit a most offensive smell. When the anburies are divided, they are hard; but with the assistance of a lens, veins or string-like vessels may be seen dispersed through the tumour. When turnips are affected with this disease, the tops become yellow, and flag in the heat of the sun, and its existence is thus readily distinguished. He says it has been attributed to the land being too long continued under this green crop; but it is certain that the anbury appears on land where turnips had never before been grown. He, however, considers that it proceeds from the formation of an insect in the vessels of the tap-root, by which the course of the sap is divided, and instead of the natural bulb an excrescence is produced. He recommends that the diseased plants should be removed as soon as possible, and the earth stirred about those that remain; and he adds, that it may be wholly avoided by well preparing and richly manuring lands subject to produce anbury. ‡ If the disease were occasioned by the puncture of insects, better cultivation would not abate its virulence, but rather increase it, as the turnip would thereby be rendered much more palatable to them. The truth is, all such diseases arise from poverty of the soil, either from want of manure when the soil is naturally poor, or rendered effete by overcropping. Labour, clean, and manure the soil fully, according to the condition it presents, and no anbury will appear, unless it may happen

* *Journal of the English Agricultural Society*, vol. iv. p. 103-121.

† *Gardener's Chronicle* for 1843.

‡ *Marshall's Rural Economy of Norfolk*, vol. ii. p. 33.

in peculiar seasons, which always counteract the effects of culture, and affect plants in a manner similar to want of nourishment. This disease is not so prevalent as it was 30 years ago, because the culture of the turnip is now better understood, and the ground is manured with greater liberality.

3313. Insects are invariably found in the bulbs of turnips diseased with anbury, but they are the effect and not the cause of the disease, as the habits of the insects so found clearly indicate. The principal insects are the winter turnip-gnat, *Trichocera hiemalis*, belonging to the family Tipulidæ, and one or two of the rove-beetles, principally of the genera *Aleochara* and *Oxytelus*, of the latter of which the sculptured rove-beetle, *Oxytelus sculpturatus*, is the most common. Both these kinds of insects are to be found among dung after it has been a few days dropped, and in rotten turnips, particularly in the diseased parts.

3314. *Fingers and Toes in Turnips.*—Of this disease Mr Dickson says:—"It occasionally happens that turnip-plants, instead of swelling and forming bulbs, send off numerous stringy roots, which soon decay and come to no account. It occurs most generally when the crop is sown on fresh land, and no remedy is said yet to have been discovered to prevent it. More perfect tillage, and the use of such measures as have a tendency to render such lands more mellow and friable, may perhaps be beneficial."* No doubt the disease has been observed on fresh virgin soil, that had never before borne a crop of turnips; but it has been remarked in a long experience, that land which had often carried turnips was most affected by this disease. The county of Roxburgh was much afflicted with it, and it continued to increase for 30 years; but latterly it has decreased, and may now be said to have disappeared, in consequence of the superior manuring of all the crops and the larger liming of the soil, and the same result has been experienced everywhere. I may here remark, however, that spurious seed will have the same effect on the turnip, in unfavourable seasons, as want of manure, and the injurious effects of weather, such as was the case in Scotland in the season of 1847. The disease affects the turnip plant from the period of singling to the first hoeing of the crop. The plant becomes flaccid, and the leaves assume a yellowish hue, but do not die, nor does the plant bear the slightest mark of insects; and when once affected never gets free of the disease, and continues to live and grow in size. The disease never affects a whole field at once, nor does it run along drills, but invariably begins in spots which increase in diameter, and spread out into large patches, which patches never come in contact, but, on finding interruptions, assume irregular forms. The interruptions are the ends of drills and the hollows of fields. The patches never commence in hollows or drill-ends where water may lodge, but on the driest

knolls, where sheep would take to and rest on for the night. In conformity with this circumstance, light loamy turnip-soil, on an open bottom, is much more apt to produce the disease than clay-land, or any soil resting on a retentive bottom; and it prevails more in dry than in wet seasons. Hence in the wet seasons of 1816 and 1817 it was but little felt in Roxburghshire; whereas in the dry summers of 1818 and 1819, and particularly in 1818, it was both extensive and destructive. Hence also Roxburgh, with its light soil, was always more affected than the neighbouring county of Berwick with its heavy soil. The ultimate effects of the disease are to produce a distorted bulb like a boxer's glove, with fingers and thumb, which are longer or shorter, smaller or larger, in proportion to the bulb. The leaves are unhealthy in colour, and the top has a tendency to shoot. Inequalities occur in the bulb which collect water, the freezing of which in winter causes premature decay of the bulb. The texture of the bulb becomes fibrous, its juice tastes acrid like the skin, and the smell is somewhat putrescent. Hence the disease affects the weight of the crop, as also its nutritive properties as an article of food for live stock.†

3315. The analyses of the tops of turnips, as well as of the bulbs attached to them, have been made by different chemists. In conducting such analyses of the tops, it has been found that the proportion of the water in them to the ash, taken in both the wet and dry states, is as follows, according to Professor Way and Mr Ogston:—

Turnip-top	Water.			Ash.			Ash-dry.		
	High.	Low.	Mean	High.	Low.	Mean	High.	Low.	Mean
	90.0	79.0	85.5	2.64	1.19	1.84	18.00	8.00	12.98

The mean numbers are those of 30 different analyses, and not of the highest and lowest quantities; but it is evident that the percentage of water and ash varies with tolerable uniformity, both above and below the averages given.

3316. Professor Johnston ascertained the proportion of water contained in different parts of the tops of turnips, before and after the formation of the bulb. Thus—

	Mean per cent.
From June 28 to July 26, the water in the entire top was,	88.49
From Aug. 2 to Sept. 27, water in the top,	85.42
.. .. . at the bottom,	90.22

The conclusions which these results warrant are, that the proportion of water is greater when the plants are young and succulent; that the percentage of water in the lower part of the top is greater than in the upper; and that the average quantity of water in the lower part is greater than the mean of the whole green part, including leaves and stalks.‡

3317. The composition of the ash of the turnip-top, as ascertained by Professor Johnston, is as follows:—

* *Dickson's Practical Agriculture*, vol. ii. p. 666.

† *Quarterly Journal of Agriculture*, vol. i. p. 429.

‡ *Transactions of the Highland and Agricultural Society*, for July 1848, p. 281-3.

Potash,	28.65
Soda,	5.41
Lime,	23.27
Magnesia,	3.09
Oxide of iron,	0.86
Phosphoric acid,	9.29
Sulphuric acid,	12.52
Chlorine,	16.05
Silica,	0.86
	100.00

Percentage of ash from 14. to 20.

Professor Johnston says there is no doubt the proportion of ash varies very much with the period of the plant's growth, and with the part of the tops which is burned for the collection of ash.* The variety of turnip from which the analysis was taken is not mentioned, but in a case the following results were obtained in illustration of these remarks:—Percentage of ash obtained from green turnip-tops, collected from the 2d of August to the 27th September from the top, mean, 2.19; from the bottom, mean, 1.75. From the same, when dried at 212° Fahr. top, mean, 16.84; bottom, mean, 18.21. The conclusions which these results warrant are, that the proportion of mineral matter in the tops increases with the age of the plant; that the average quantity of mineral matter in the green part of the turnip is greater in the highest than the lowest part; and that in the tops dried at 212° Fahr., the proportion of mineral matter is greater in the lowest than in the highest part. As regards this change of place in the proportion in the mineral matter in the tops when green and dried, Professor Johnston gives an explanation, which you should bear in mind when comparing the results of chemical analyses in other things:—"This difference arises from the circumstance that the lower part contains the largest percentage of water. The present case is only one of many illustrations of the fact, that the relative proportions of mineral matter, in green products, are not to be received as real indices of the relative proportions in which this mineral matter exists in the dry substance of the plant."†

3318. The following table exhibits the composition of turnip-tops of the respective varieties of the turnips mentioned in it, as ascertained by Professor Way and Mr Ogston:—

	Skirving's Swede.	Dale's Hybrid.	Green Top White.	Mean of six specimens.
Potash,	11.56	20.79	13.53	12.35
Soda,	12.43	..	4.60	..
Lime,	28.49	30.38	35.10	24.27
Magnesia,	2.62	3.18	1.75	3.57
Oxide of iron,	3.02	0.66	0.61	3.49
Carbonic acid,	6.18	12.97	13.82	6.10
Phosphoric acid,	4.85	6.21	4.58	11.70
Sulphuric acid,	10.36	12.20	6.71	6.99
Chloride of sodium,	12.41	10.31	18.02	22.70
Chloride of potassium, . . . . .	..	2.60	..	1.84
Silica,	8.04	1.14	1.26	7.35
	99.96	99.93	99.98	99.96
	99.96	99.93	99.98	99.96
Percentage of ash,	1.97	1.95	1.19	2.25
				1.82

This table exhibits wide differences in the composition of the ash of the turnip-top, the phosphoric acid of one specimen being double that of others. We are prepared for this, observes Professor Way. In the growth of plants of this description, the construction of the materials is supposed to go on in the leaves from which the vegetable matter, when fully worked up, descends into the tuber, and is there deposited. The leaves would contain, therefore, not only their own proper mineral constituents, but the greater part of the excess of such bodies which had entered the plant. The ash of the top differs from that of the bulb chiefly in containing less phosphoric and sulphuric acid, less potash, but a great deal more lime. On comparing the contents of the column of mean results with that of Professor Johnston (in 3317.) a great difference will be observed to exist in the composition of turnip-tops derived from different localities.

3319. It may be useful to give the relative quantities of the mineral matter, in pounds weight, contained in one ton of the tops of each of the kinds of the turnips given in the above table:—

	Skirving's Swede. lb.	Dale's Hybrid. lb.	Green Top White. lb.	Mean of six specimens. lb.
Potash,	5.09	9.08	3.61	6.20
Soda,	5.49	..	1.23	..
Lime,	12.57	13.26	9.37	12.18
Magnesia,	1.16	1.39	0.47	1.79
Oxide of iron,	1.33	0.29	0.16	1.55
Phosphoric acid,	2.15	2.71	1.92	5.87
Sulphuric acid,	4.57	5.33	1.79	3.51
Chloride of sodium,	5.48	4.51	4.81	11.40
Chloride of potassium, . . . . .	..	0.91	..	0.92
Silica,	3.55	0.50	0.34	3.69
	41.39	37.98	23.00	47.11
	41.39	37.98	23.00	47.11
Percentage of ash,	1.97	1.95	1.19	2.25
				1.82

3320. The leaves of turnips contain much more common salt, chloride of sodium, than the bulbs, and the quantity is considerable in some cases, the second column of Dale's hybrid above exhibiting an amount of it of 1½ lb. to the ton, or about 9 oz. to every cwt. of the green tops. May not this circumstance in part explain the action of turnip-tops in causing purging in sheep when they are first turned upon this food from pasture? The other alkaline salts, such as the phosphates of soda and potash, and organic salts of these bases, oxalate, tartrate, &c., and which are known as purgatives, exist largely in turnip-tops.‡

3321. A rather singular result was obtained by Mr Johnstone, Lang-Liddesdale, Wigtonshire, on transplanting swedes on land which he had not got ready for sowing them in at the proper season. He sowed some seeds of Skirving's swedes in a bed in April 1847, and transplanted the plants from them as late as the 22d of June. From ten to twenty days afterwards, the transplanted plants running into flower, some of them were pulled up, and others cut over near the ground; when, in about fourteen days afterwards, bulbs

* Johnston's Lectures on Agricultural Chemistry. 2d edition, p. 385.

† Transactions of the Highland and Agricultural Society, for July 1848, p. 283.

‡ Journal of the English Agricultural Society, vol. viii. p. 176-84.

began to form, and new stems and leaves were put forth luxuriantly. He then cut over others which had flowered, and the same results followed. Finding the new leaves succulent and delicate, he caused them to be pulled as green food for his cows, and continued to do so during the season, three times, never imagining that the bulbs would ever be of any value. Meanwhile, however, the bulbs enlarged until the latter end of October, when two were pulled, and one weighed 18 lb., the other 15 lb., with scanty stem and leaves, because the former ones had been cut down not long before.

3322. The question, after such treatment of the bulbs, was, were they deteriorated as food? From an analysis made of them by Professor Johnston, it would appear they were not—as may be seen from these figures:—

	In the natural state.	Dried at 212°.
Water,	90.95	...
Protein compounds,	1.28	14.14
Sugar, gum, fibre, &c.,	7.17	79.23
Ash of phosphates,	0.60	6.63
	100 00	100 00

The nutritive power not having been diminished, is it probable that green food may be obtained all summer from the Swedish turnip, and enlarged size of bulb for winter in the same season? The subject deserves to be experimentally investigated, when only a true answer will be obtained to the question. I think, however, that the transplanting process is merely incidental, and cannot affect the result; for it is evident that the plant will produce new stems and leaves, and consequently bulb, whether it had been grown from seed sown at one place, or sown elsewhere and transplanted in that place.*

3323. *Bone-dust.*—Bone-dust has now completely established itself as a valuable manure; and I believe that, with the exception of farm-yard dung, there is no substance we know upon which we may place more implicit reliance, in one or another of its states, as a fertiliser of the soil, not even excepting guano.

3324. One of its most valuable properties as a manure is its durability; and in this respect it is superior to farm dung and guano. Bones, even in their reduced state, when applied in large quantities, as $1\frac{1}{2}$ ton and upwards on the acre, as is done by the farmers of Cheshire, will evidence their existence as a manure after the lapse of 20 years. This result arises from the slowness of the decomposition of their organic matter in the soil. I pulled off 4 acres of turnips raised with bone-dust, and four acres adjoining in the same field, which had been raised with 15 loads of farm-yard dung to the acre; and the crop was not only better after the bone-dust than after the dung, but the crops that followed in the rotation

—namely, barley, hay, pasture, and oats—were all better in their respective years.

3325. Thus Marchand found the bones of a bear that had been buried for an indefinite time at a shallow depth—where moisture and air may have been supposed to have exercised their influences very actively—not to have differed very materially in composition to other bones of a bear that had been buried deeply, except in animal matter, as is shown in the following table:—

	Bones of the Bear buried.	
	Deep.	Shallow.
Animal matter,	16.2	4.2
Phosphate of lime,	56.0	62.1
Carbonate of lime,	13.1	13.3
Sulphate of lime,	7.1	12.3
Phosphate of magnesia,	0.3	0.5
Fluoride of calcium,	2.0	2.1
Oxides of iron and manganese,	2.0	2.1
Soda,	1.1	1.3
Silica,	2.2	2.1
	100.0	100.0

That substance must be a valuable manure which resists decomposition for a long time, while it imparts nourishment to the roots of plants as they require it.

3326. Bone is a dense substance, as will be seen by the specific gravity of different kinds as determined by Dr Thomson:—

Os femoris of a sheep,	2.0345
Tibia of a sheep,	2.0329
Ilium of an ox,	1.8353
Human os humeri,	1.7479
Vertebrae of a haddock,	1.6350†

It thus appears that the bones of sheep are denser than those of oxen.

3327. Bones contain a large proportion of water, the quantity of which is greatest when the animal is young, and the interior of the bone spongy, varying from 33 to 15 per cent in the former and from 20 to 30 per cent in the latter case, in different animals.

3328. Bones are composed of organic and inorganic matter, the former consisting of fat and cartilage, the latter of earthy matter. The inorganic matter varies in the bones taken from different parts of the body. When the fat has been removed, the proportion of earthy matter to cartilage is as follows, according to the experiments of Dr Stark:—

	Earthy matter.	Cartilage
Bones of the ox contain,	64.5	35.5
horse,	66.7	33.3
pig,	64.7	35.3
birds,	66.2	33.8
fishes,	66.1	32.9

In the earthy matter the bones of different animals do not thus vary much. The earthy mat-

* *Transactions of the Highland and Agricultural Society*, for March 1848, p. 241.

† Thomson's *Animal Chemistry*, p. 234.

ter consists chiefly of the carbonate and phosphate of lime; and Dr Ure says, "that the bones of the ox are three times richer of the phosphates of lime and magnesia than those of man, and hence we may conclude that as manure they are more valuable."*

3329. When bones are boiled, a large proportion of the fat and cartilage pass into the water. The fat is skimmed off the surface of the water, and is used by the candle-makers; the water, when boiled down, makes size for the stiffening of certain kinds of cotton goods. The bones, after being boiled, contain more water than they did before, and when ground into dust make as good manure as when fresh, according to the opinion of some. But it is evident that the loss of the fat and cartilage must deteriorate the value of bones as a manure for general application. It is probable that the additional water obtained by the boiling may facilitate the decomposition of the bone-dust in the soil, and thereby give to the boiled bone a factitious value.

3330. The organic parts of bones, when heated to redness in the open air, are dissipated, and the earthy matter is left in the form and bulk of the original bone. The calcined bones, which are very brittle, and easily reduced to powder, get the name of *animal charcoal*, but its proper name is bone-black, which constitutes a valuable manure in some cases.

3331. Bones, when subjected to the action of steam heat, equal to a pressure of 35 lbs. to the inch, become spongy and brittle, and may be reduced easily to powder. This process has lately been introduced to notice by Mr Blackhall of Edinburgh, as a means of reducing bones to powder in a more economical manner than by the powerful machinery which is necessary for the construction of a bone-grinding mill. But the analyses by Dr Anderson make it appear that steaming deprives bones of much animal matter. Thus, in two instances, steamed bones gave of

Water,	12.66	13.86
Animal matter,	27.37	19.90
Bone-earth,	59.97	66.24

100.00	100.00
--------	--------

And that of bones in three states gave, from

	Inch bones.	Bone-dust.	Entire bones.
Water,	10.00	10.39	14.89
Animal matter,	41.88	42.60	37.04
Bone-earth,	48.12	47.01	48.17
	100.00	100.00	100.00

Hence the loss of animal matter is as 27 to 40; and hence, also, if crude bones cost £4 the ton, steamed bones would cost £5, 6s. 8d., besides the expense of steaming.† It has been more recently stated that steaming bones at a pressure of 50 lb. to the square inch, reduces them to a state of pulp. That the steaming process will deprive the bones of most of their organic matter is evident, since

the French have long been in the practice of steaming them for two or three days in continuation in the making of soup.

3332. It is the opinion of both Sprengel and Liebig, that it is the earthy portion of the bone, and particularly the phosphate of lime, which is alone useful as manure in bone-dust. Some experiments may have warranted such a conclusion; but others, on the other hand, would lead to the conclusion, that it is only the organic part of bones which is useful in manure. Such results would depend upon the degree in which the soils experimented on at the time had been previously supplied, from other sources, with organic or inorganic matter. "The most striking change," as Professor Johnston observes, "undergone by bones buried at the roots of trees, was the large loss of organic or animal matter they had suffered. The relative proportions of the phosphate and carbonate of lime had been comparatively little altered. The *main* effect, therefore, produced by bones, when buried at the roots of trees, as particularised in the table in (3325), and their first effect, in all cases, must be owing to the animal matter they contain—the elements of the animal matter, as it decomposes, being absorbed by the roots with which the bones are in contact. He who candidly weighs the considerations above presented, will, I think, conclude, that the whole effect of bones cannot in any case be ascribed exclusively either to the one or the other of the principal constituents. He will believe, indeed, that in the turnip husbandry the organic part performs the most permanent and most immediately useful office, but that the earthy part, nevertheless, affords a ready supply of certain inorganic kinds of food, which in many soils the plants could not otherwise easily obtain. He will assign to each constituent its separate and important function, being constrained at the same time to confess—that, while in very many cases the *earthy part of bones applied alone* would fail to benefit the land, there are few cultivated fields in which the *organic part applied alone* would not materially promote the growth of most of our artificial crops."‡

3333. The comparative value of bones and farm-yard dung was ascertained by Dr Henry R. Madden. This is his analysis of both:—

BONE-DUST.

Water,	11.5
Organic matter,	57.7
Inorganic matter,	30.8

100.00

FARM-YARD DUNG.

Water,	45.535
Organic matter,	43.565
Inorganic matter,	10.900

100.000

§334. Another analysis gave of azote in bone-

* Ure's *Dictionary of the Arts*—art. *Bones*.

† *Transactions of the Highland and Agricultural Society*, for July 1849, p. 22.

‡ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 789.

dust 1.77 per cent, in farm-yard dung .45; so that, with respect to azote, these substances stand comparatively thus in—

	Bone-dust.	Farm-yard dung.
Total organic matter,	38.50	33.565
Soluble matter,	10.20	10.750
Easily rendered soluble,	41.50	14.250
Azote,	1.77	.450
Saline matter,	55.00	10.900

Hence 1 ton bone-dust equals, as regards—

	1 ton farm-yard dung.
Organic matter,	1
Soluble matter,	1
Easily dissolved do.,	2.9
Azote,	3.9
Saline matter,	5
Earthy phosphates,	18.3

“If all the various degrees in which bone-dust is superior to farm-yard dung be added together,” concludes Dr Madden, “1 ton of it equals 30 tons of dung; but as only 16 bushels of bone-dust are applied to the acre, which, at 47 lb. per bushel, weigh 7 cwt., this quantity is equal to 10½ tons of dung.”*

3335. Bone-dust is less efficacious as manure on clay than on light land; nor does land which has been recently limed experience the same benefit from bone-dust as land devoid, or nearly so, of lime.

3336. Bone-dust is obtained from those who grind bones, with heavy and costly machinery, constructed for the purpose, and bone-mills are now common over the country, at least in all the large seaports. Hull is the great emporium of this article. When bone-dust is purchased on ship-board, it is almost always adulterated with old plaster, brick-dust, ashes, &c., and should therefore be purchased direct from the grinder—from one, if possible, on the spot. To avoid such adulteration, an association of farmers was formed a few years ago in Perthshire to import bones, rape-cake, &c., and grind them at their own mills under the superintendence of a manager in whom they had confidence, and they thus supplied themselves with genuine manures.

3337. Bone-dust is best conveyed from the mill in sacks, and 40 bushels will fill a double-horse cart and sow 2½ acres. It weighs 47 lb. per bushel. It should be immediately emptied out of the sacks and kept in small heaps in a cool shed until it is used, as it is very apt to heat; and one consequence of recent heating is, to become lumpy and troublesome to sow by the bone-dust sowing machine, fig. 259, though otherwise it is not injured but rather improved by it.

3338. If fresh bone-dust just obtained from the mill is desired to be heated at once, which it should be if it is to be kept for a few months, the process is much accelerated by the addition of a little sifted coal-ashes or earth, and as much water as will make the whole mass only damp, and by turning it over several times until it is incorporated; and in 48 hours the heat will be so great that you cannot hold your hand in it. The heat will gradually subside, the mass

become dry, and be in a good state for passing through the sowing-machine.

3339. Although it is improbable that you will keep bone-dust over the year, it being more profitable to put it into the ground, yet in case you should have any left over, or should purchase a lot cheap out of season, it may be proper to let you know how to keep it in the best, state until it is used. It is this: whenever you get it, you should put it on a dry pavement floor, as a damp one quickly rots it. It will heat, but not so strongly as when it was grinding, and it will heat every time it is turned, which it should not be. It should not be kept in the bags, as it will soon rot them, as I have experienced, nor should it be kept upon or under a wooden floor, as it will rot it; nor should it be kept near horses and cattle, as they evince a strong dislike to its smell; and horses actually become restive and troublesome on feeling the smell it emits.

3340. Heating has the effect of increasing the weight of bone-dust from 47 lb. to 49 lb. per bushel, and this increase is no doubt effected by the heating taking off the angles of the particles, and allowing them to come closer together in the bushel. The colour is also changed to blue and yellow, and, on examination with the microscope, the mass contains numbers of minute insects like mites.

3341. The consumption of bone-dust as manure must have been great before the introduction of guano; and, even in my own experience of its use, it rose in price from 2s. 6d. to 3s. 6d. the bushel, on account of the increased demand, which continued to increase until the use of guano was known. It is now imported duty-free, and its price has receded to the original amount of 2s. 6d. the bushel.

3342. By a parliamentary return, the quantity of bones imported from abroad in 1847 was 29,646 tons, and in 1848, 32,582, the increased 2936 tons implying an increasing demand for bone manure, notwithstanding the use of guano.

3343. *Guano*.—Guano is the Peruvian word *huano*, meaning dung, so spelt by the Spaniards. It is an excrementitious deposit from myriads of cormorants, flamingos, cranes, &c. and is found in the highest perfection in the small granite islands 10 miles from Chincha, off the coast of Peru, in latitude 14°, to Paquica, on the coast of Bolivia, in latitude 21° S. Little or no rain falls in this district, and it is to the desiccating effect of the sun that the valuable state of the guano is to be ascribed. Rain falling in the districts beyond those latitudes, the guano from Chili is not so good as that obtained from the Peruvian port Iquique, having undergone a certain degree of fermentation.

3344. If guano be compared with the excrementitious matter from man and the mammalia, it will be found to be very superior, inasmuch as the urine and dung of that class of animals are evacuated separately, and each has its own

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 529-31.

peculiar action on vegetation; whereas in birds the excretions both of the kidneys and intestines are contained in the cloaca, whereby the volatile elements of the former become combined with the more fixed components of the latter: and guano should be a richer manure than the excrements of the mammalia, on account of its being produced by sea-fowl which live entirely on fish, without admixture of vegetable matter.

3345. So much do the farmers of Peru appreciate the value of guano as a manure, that they bring the nitrate of soda from the interior to the coast to exchange for guano, though the nitrate is much cheaper. The farmers themselves collect the nitrate and purify it. From ordinary applications, the returns from the nitrate upon maize is only 15 to 1, while that from guano is 300 to 1. Hence the Peruvian proverb—Huanu, though no saint, works many miracles.

3346. Pure Bolivian guano possesses these properties:—Pale yellow brown colour, dry, partly pulverulent, partly concreted, in small lumps, with small fragments of granite interspersed. Specific gravity of the pulverulent portion without the granite 1.60, of the concretions 1.66, mean 1.63. No ammoniacal smell should be felt, and when present it is a sure proof of decomposition. The Chilian guano always emits such a smell. Genuine guano, when burned on a hot shovel leaves a white ash of phosphate of lime and magnesia.

3347. Guano has been found on the coast of Africa, in the island of Ichaboe, and in Saldanha Bay, and on account of the high price of Peruvian, these African deposits were highly prized; but as the supply from them was scanty, it was soon exhausted. The guano from those sources was of a very inferior description to that from Peru. I have heard that a recent visit to Ichaboe has discovered new deposits of guano there, so that the birds must have returned to their former haunts. Were these deposits placed under responsible authority, as are those of Peru, it is probable that they might yield a continued supply of good manure, but if left to commercial rivalry, the birds will again be driven away, and the guano will be taken as individual caprice and interest dictate.

3348. Dr Ure, among many analyses of guano, made an elaborate one of a sample from Chincha; and as this sample may be regarded as a type of the substance in its best state, its composition should be a standard for comparison:

		Ammonia.		
Matter soluble in water.	{	Sulphate of potash, with a little sulphate of soda,	6.00	0.95 4.62 0.34 0.50 0.89 8.50 8.95 47.00
		Muriate of ammonia,	3.00	
		Phosphate of ammonia,	14.32	
		Sesqui-carbonate of ammonia,	1.00	
		Sulphate of ammonia,	2.00	
		Oxalate of ammonia,	3.23	
		Water,	8.50	
		Soluble organic mat- ter and urea,	8.95 47.00	

Matter insoluble in water.	{	Silica,	1.25	123
		Undefined organic matter,	9.52	
		Urate of ammonia,	14.73	
		Oxalate of lime,	1.00?	
		Subphosphate of lime,	22.00	
		Phosphate of magne- sia and ammonia,	4.50 53.00 0.32	
				100.00 9.80

3349. Two samples of guano were analysed in 1847 by Professor Johnston, one of which was obtained in 1846 and kept in a dry room, the other in 1847, both from Messrs Meyer & Co., Liverpool. He also analysed in 1848 two samples, one of Chilian and the other said to be Peruvian, both obtained from Glasgow. All the analyses were made at the request of Mr Cranston of Corehouse, Lanarkshire. The results were these:—

	1846. Peru- vian.	1847. Peru- vian.	1848. Chi- lian.	Peru- vian.
Water,	7.83	15.14	5.03	8.70
Organic matter with amonia- cal salts,	59.85	51.64	12.75	55.73
Common salt, sulphate of soda, with a little phosphate of pot- ash and soda,	12.24	7.67	15.86	6.23
Phosphates of lime and magnesia,	15.15	29.72	47.35	26.48
Carbonate of lime,	0.97	2.26	10.27	0.72
Insoluble siliceous matter,	3.39	1.71	8.74	2.14
				99.43 99.14 100.00 100.00

The Peruvian guanos of 1846 and 1847, obtained direct from Meyer & Co., proved excellent; and that of 1848 was also good, and much better than the Chilian used at the same time, and for the same purposes.

3350. After many analyses of guano of the best description, Dr Ure was enabled to establish the following formula as an average result, and which has reference solely to its agricultural value:—

Azotised animal matter, including urate of ammonia, together capable of affording from 8 to 16 per cent of ammonia by slow decomposition in the soil,	50.	
Water,	8. to 11.	
Phosphate of lime,	12. to 25.	
Phosphate of ammonia, sulphate of ammonia, ammonia, phosphate of magnesia, together containing from 5 to 9 parts of ammonia,	13.	
Siliceous sand,	1.	
		100.

3351. Guano is adulterated to a great extent, and one sample, offered to the public by advertisement as Peruvian, Dr Ure found to contain the following ingredients:—

Common salt,	32.0	
Common siliceous sand,	28.0	
Sulphate of iron, or copperas,	5.2	
Phosphate of lime,	4.0 with	
Organic matter from bad guano, &c. to give it a smell,	23.3	
Moisture,	7.5	
		100.00

This stuff had a specific gravity as high as 2.17 produced from the salt, sand, and copperas; and,

when burned in a hot shovel, left a black fused mass of sea-salt, copperas, and sand.* No farmer should therefore purchase guano without having it analysed by a competent chemist; and in guarding the interests of farmers in this respect, the late Agricultural Chemistry Association of Scotland was eminently useful. The Highland and Agricultural Society of Scotland in their chemical department will be equally protective of the farmers' interest. The sure way to purchase genuine guano is to order it only from Messrs Gibbs of London, or Messrs Meyer & Co. of Liverpool, who are the accredited agents of the Peruvian government in this country.

3352. Peruvian guano is always high-priced in this country, being seldom below £10 the ton, not only on account of its superiority to other kinds—and the longer voyage no doubt incurs a larger freight than the African—but the export-duty imposed on the shippers from Bolivia enhances the value £3 a ton. African guano is sold for £5 or £6 a ton, and the Chilian for £7.

3353. Guano is now imported duty-free, and the importation in 1847 was 82,393 tons; in 1848, 71,414 tons, which gives a falling off of 10,979 tons in one year, which, at 3 cwt the acre, indicates a want of the means of manuring for 79,860 acres in 1848 compared with 1847,† but the increase in the importation of bones in the same period would manure 11,248 acres, at 16 bushels the acre.

3354. About 4 or 5 cwt. is the quantity of guano which experience has ascertained to be required for the acre when applied alone, and 3 cwt. in conjunction with farm-yard dung.

ON THE SOWING, AND THE SUMMER TREATMENT OF KOHL-RABI.

3355. Kohl-rabi, or the turnip-rooted cabbage, is a plant of recent introduction into the agriculture of Britain. Attention was directed to it in consequence of the properties it possesses of withstanding drought, and being little subjected to the attack of insects—properties which impart to it an intrinsic value over Swedish turnips. Still it was a question whether it would afford a large enough crop to become a substitute for swedes; and it appears, from recent experience, that it is capable of affording, in certain localities at least, a heavy crop.

3356. Agreeing with heat and drought, it may suit the climate of the south of England, to which it has hitherto been confined; but it is, I suspect, too delicate

for the climate of Scotland, although it may be raised in favoured spots, such as gardens. In Ireland it has been successfully cultivated for years.

3357. As kohl-rabi holds the same position, as a crop, as the turnip, its culture is very similar; but while turnips affect the lighter soils, kohl-rabi thrives on the stronger, so it may be raised where turnips cannot be. The stubble-land in the beginning of winter is either gathered up with gore-farrows (749 and 756) or cast with the same, (755 and 756.) In spring it is cross-ploughed, (2613.) drilled in the single way, (2389.) manured in the drill, (2749,) redrilled in the double way, (2397.) and made ready for the seed, as in the case of turnip culture. All these operations should be gone through by the 1st of May, and before the land for the earliest of the turnips is required.

3358. Either of two modes may be adopted in cultivating kohl-rabi—to transplant plants, or sow the seed. If the method of transplanting is adopted, a piece of good ground in a favoured aspect should be prepared in February or beginning of March, by deep digging and manuring, and sowing the seed in rows of 12 inches apart, and not very thick in the row. The rows admit of the ground being hoed with the hand-hoe, fig. 266, which it should occasionally be, not only to keep down surface-weeds, but to loosen the soil for the encouragement of the growth of the plants. The plants should be raised and carried to the field to be transplanted, in the manner already described for transplanting swedes, (3269,) in the first week of May, before the sowing of the swedes about the 15th of May. As damp and cloudy weather is the most favourable state of the air for transplanting plants, it should be chosen for the purpose; and the operation may be forwarded or retarded before or after the ordinary time, for the sake of obtaining the assistance of such weather.

3359. But as transplantation is attended with considerable trouble, the crop is equally secure when sown in the seed; and the seed may be sown either by itself, with the common turnip-sowing machine,

* *Ure's Dictionary of the Arts, and Supplement*—art. *Guano*.

† *Parliamentary Return*, 26th February 1849.

fig. 254, or along with manure, with the bone-dust sowing-machine, fig. 259. The quantity of seed may be the same as swedes, namely 3 lb. the acre. And as bone-dust is not favourable to strong soil, the manure selected should be bone-dust prepared with oil of vitriol, termed sulphated bones, (3233.) The seed is dear—it costs 2s. 6d. per lb.; on which account, it has been recommended to be sown with manure with the drop-drill sowing-machine, fig. 261, or dibbled in at intervals along the drill. I think the saving would not compensate for the trouble of dibbling, or the purchase of a drop-drill machine.

3360. When the seed is sown, the crop is singled the same as turnips with the hand-hoe, (3259,) and the intervals left between the plants may vary from 12 to 15 inches, according to the vegetating power of the soil. The cleaning of the ground with the scuffler, fig. 262, and with the drill-grubber, fig. 264, is the same as in the case of the turnip, (3256;) but when the finishing operation is arrived at, the ground between the rows should not be left somewhat flat, as recommended for the turnip, (3277,) but raised with the double mould-board plough, fig. 209, as high as just not to cover the bulb upon the stem of the plant, and this setting up should not be executed until the bulbs have attained the size of a man's hand.

3361. With 16 tons of good farm-yard dung, and 4 or 5 cwt. of sulphated bones to the acre, a crop of from 20 to 30 tons may be expected to be raised. Kohl-rabi will yield a heavier crop than swedes on clay land, but not so heavy on turnip soil. A sprinkling of 2 cwt. of guano to the acre, around each plant after they are singled, would tend to increase the size of the bulb materially.

3362. The advantages which kohl-rabi is said to possess over Swedish turnips by those who have cultivated it in England and Ireland, are these:—cattle, and especially horses, are fonder of it; the leaves are better food; it bears transplanting better than any other root; insects do not injure it; drought does not prevent its growth; it stores quite as well or better; it stands the winter better; and it affords food later in the season, even in June.

3363. Two varieties of kohl-rabi are cultivated—the green and the purple. The green gives the heavier crop, but the purple the more nutritious one.

3364. Specimens of kohl-rabi have been raised in Scotland weighing from 5 lb. to 7½ lb. each; in Ireland, individual bulbs have attained the weight of 14 lb.; and in England they commonly reach from 8 lb. to 10 lb.

3365. As kohl-rabi stands in the same position in the Linnæan, Jussieuan, and natural system of Lindley, as the turnip, it is unnecessary to repeat the particulars which have been already given in (3283.) Its specific name is *Brassica oleracea, caulorapa, alba*, of De Candolle, and, as this name indicates, it is a variety of the common cabbage. Its peculiar character is in having its stem towards its upper extremity swollen into a large globular pulpy mass, in consistence and texture somewhat resembling a Swedish turnip; from and near the summit of which mass the leaves, which are smooth, and of various shapes and shades of colour, are produced. The taste of the pulpy mass is very similar to that of the heart of the stem of the cabbage.

3366. The kohl-rabi is used in Germany as a vegetable for the table. In whatever way it is cooked, it is a coarse, harsh vegetable; and yet we hear people in this country recommending its culture in the gardens of the poor, as a suitable esculent for their use; but why the vegetables eaten by the poor labouring man and his family should be coarser than those for other people, it is difficult to perceive. If mere bulk of crop is a recommendation of it for the poor, the Swedish turnip becomes bulky enough for such a purpose, and it is actually better tasted, even when plain boiled, than the heart of a cabbage stem, to which that of the kohl-rabi has been very truly likened.

3367. The kohl-rabi is an excellent food for cows and horses, and, when boiled with grain for their use, will afford them true nourishment. The leaves may also be used, having entirely the character of a true cabbage; but they should be removed with a sparing hand, else the enlargement of the bulb will be prevented.

ON THE PLANTING, AND THE SUMMER TREATMENT OF THE CABBAGE.

3368. The cabbage may be usefully and successfully raised on a farm; and, occupying the same position in the order of cropping as the turnip and potato, it is planted on the fallow break. It likes a rich deep soil with a considerable proportion of clay.

3369. The cabbage, up to the time of laying the dung in the drill, is cultivated in precisely the same manner as are turnips and potatoes. As the cabbage requires much manure, 20 tons to the acre of farm-yard dung should be given, and at least 2 cwt. of guano sown by hand over the dung. The drills are then set up in the double form, (2397;) and just before the plants are planted on the drills, a light roller, of the form of fig. 222, should flatten their tops, and reduce the soil on them to a fine state. The turnip-sowing machine, fig. 254, with the coulters removed, will do this work well with its curved rollers.

3370. Cabbages may be raised by sowing the seed in the drill, as with turnips, or by transplanting prepared plants. The transplanting is much the preferable and secure plan for raising cabbages. The plants are prepared in this way: Plough, or dig with the spade, a piece of ground, which has grown early potatoes or tares for the horses in harvest, with a sprinkling of manure upon it, and sow the cabbage seed, either broadcast, which is the common mode, but better in rows at 12 inches apart, and fence the plot from trespassers during the winter. Hoe the ground between the rows, and keep it clean. From the end of March to May, take the best of the plants in the manner described in transplanting Swedish turnips (3269,) and transplant them in moist or dull weather on the newly prepared flattened drills, at 2 feet apart; and at this distance, with 27 inches between the drills, 9680 plants will be required for the acre. When purchased from nurserymen or gardeners, the plants cost 5s. the 1000.

3371. The summer treatment of the cabbage, as regards scuffling, hand-hoeing, drill-grubbing for the destruction of weeds and the pulverisation of the surface, is in all respects the same as that of the turnip. The earth should be laid toward the stems with the double mould-board plough, fig. 209, on finishing the operations, to assist in steadying the plants, as, when the heads become heavy, the wind is apt to cause the stem to work a hole around it.

3372. The crop expected from such

treatment may be from 30 to 40 tons the acre. In Scotland, the drumhead cabbage has yielded in the field from 17 lb. to 22 lb. of individual weight, with the stem and under leaves; and from 10 lb. to 14 lb. of solidly-hearted leaves. There are a great many small cabbages in a crop, but at 10 lb. of solid heart in each plant, the yield should be 43 tons 4 cwt. the acre.

3373. The under leaves should never be plucked from the close-headed cabbage, but be allowed to drop off. Those of the open-hearted sorts, and of the kales, may be removed by the hand, and the growth of the remaining ones will be increased.

3374. The application of 2 cwt. of sulphated bones to the acre, around each plant, would greatly increase the size of the close-headed cabbage, and the leaves of the open-hearted kinds.

3375. In autumn the cabbage plant is subjected to the attacks of insects, and particularly to that of the well-known cabbage butterfly *Pontia brassicæ*, with white wings and black tips, which produces the long, beautiful, green caterpillars, familiar to every one who frequents a garden.

3376. The cabbage occupies the same place as the turnip and kohl-rabi in the systems of botany. The specific name of the drumhead cabbage—so named, I suppose, from its resemblance in size and shape to a drum, is *Brassica oleracea, capitata depressa*, and of the Scotch cabbage, *Brassica oleracea, capitata spherica alba*, of De Candolle, (893.) The large savoy, cape, or drumhead savoy, with its solid-like globular form of head, and wrinkled leaves, being both hardy and productive, might also be cultivated in the field. The tall purple German green is so cultivated.

3377. The ash left by burning the dry leaves of the cabbage leave the following ingredients, according to the analysis of Dr Fromberg:—

Potash,	11.70
Soda,	20.42
Lime,	20.97
Magnesia,	5.94
Oxide of iron,	0.60
Phosphoric acid,	12.37
Sulphuric acid,	21.48
Chlorine,	5.77
Silica,	0.75
	<hr/>
	100.00*

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 384.

I have given the quantity of mineral matter taken from the soil by a crop of 20 tons of drumhead cabbage at (894.)

3378. In the neighbourhood of large towns, farmers raise the drumhead and common garden cabbage to supply the market gardeners for planting in spring, in the manner described in (3370.) The plants are cleared off the ground early in spring, and the ground sown with spring wheat. Good plants fetch about half-a-crown the thousand.

3379. The turnip-rooted cabbage, *Brassica campestris, napo brassica communis*, of De Candolle, is little known in English culture, though it is cultivated in the fields of the north of France. Its root is white or red, and its neck and pitioles greenish or purplish. It has a woody short stem, produced by the formation and decay of the leaves; and as new leaves are formed by the central bud of the stem, the lower leaves drop off, and thus the top of the bulb assumes the appearance of a stem. Dr Neill observes that it has a root under ground as sweet as a Swedish turnip.

3380. The cow-cabbage, or Cesarean kale, *Brassica oleracea, acephala arborescens*, of De Candolle, which created so much interest a few years ago, only deserves a passing notice. "This plant," says Don, "is almost similar in habit to the palm kale, and it lasts four years without fresh planting. In La Vendée, it is said to attain the height of 12 or 16 feet. In Jersey this plant is sufficiently hardy, and there it grows from 4 to 12 feet. The small farmers there feed their cows with the leaves, plucking them from the stem as they grow, leaving the crown at the top. The stems being strong, are also used by them for roofing small outhouses. When the gathering of the leaves is finished at the end of the year, the terminating bud or crown is boiled, and is said to be particularly sweet. It is not sufficiently hardy to stand the climate of Britain, unless planted in a very sheltered situation."*

ON THE SOWING, AND THE SUMMER TREATMENT OF MANGOLD-WURZEL.

3381. Mangold-wurzel, a species of beet, is a very important green crop, and may be regarded as next so to the turnip. It contains a sweet nutritious juice, which seems well adapted for the support of cows in milk, as it imparts none of the acrid flavour which the turnip does. This root, therefore, ought to be valued on every dairy farm.

3382. There are several varieties of mangold-wurzel fitted for cultivation in the field; the long red, the long yellow,

and the globe orange, which names truly indicate their respective characters; and where the chief reliance of winter food is placed on beet in preference to turnip, all the varieties ought to be cultivated, since the globe orange thrives best on light soil, and the long yellow is in a better state for use in the early part of winter than the long red. The circumstance of beet not being a safe root to give to cattle, until it has been some time out of the ground, is the only objection, and it is a serious one, to their indiscriminate use.

3383. One and the other of these varieties will grow on any soil intermediate from a gravel to a strong clay, on neither of which classes of soil will any one succeed.

3384. The climate of Scotland does not seem to suit mangold-wurzel. I tried it in Forfarshire for three successive years on the best land I possessed, which had as well been long in cultivation as in a fresh state, but failed in two seasons out of the three; and the successful crop was but a poor compensation compared to turnips. In England it succeeds well, particularly in the eastern counties, and in the north of Ireland I have seen very heavy crops of the long red on drained bog.

3385. The mangold-wurzel being a green crop, is subjected to precisely the same culture as the turnip up to the point of ploughing the dung in the drills, and need not be repeated here. The quantity of farm-yard dung given is the same as to Swedish turnips—16 tons the acre, with 3 cwt. of guano, sown upon the dung before being covered in the drill. The land should thus be prepared for the seed early in April, and not later than the beginning of May.

3386. The seed of mangold-wurzel being covered with a rough integument, cannot be sown with a turnip-machine having the common seed-boxes. Perhaps Geldes' turnip sowing-machine, with the mode of feeding the seed described in fig. 257, might answer the purpose; and Mr Raynbird of Suffolk refers to a one-horse drill which sows three rows of seed at

* Don's *General Dictionary of Botany and Gardening*, vol. i. p. 229.

a time, over three acres in two hours.* Newberry's wheel-dibbler has also been used. I have never seen a machine capable of sowing mangold-wurzel seed well, and one that will sow two drills at a time, like turnips—and roll the drills before and after the sowing with a light roller—is preferable, for management, to one having three drills. Mr Miles uses an iron wheel, upon the circumference of which are placed iron studs at 18 inches apart and $2\frac{1}{2}$ inches in projection, to act as dibbles in forming holes along the top of the drill; but a projecting stud from the circumference of a wheel in revolution must make a hole much ragged on one side. In lack of a machine, I tried a plan of sowing which answered very well, and which I would prefer to any dibble—it was this: A light roller flattened and made even the tops of two drills at once, when the soil had become dry after the ploughing of the dung. A field-worker followed, and made a light rut along the top of the drill with the corner of a hand-hoe, fig. 266; another worker dropped the seed along the rut in the given quantity—4 lb or 5 lb to the acre—steeped or in a dry state as desired; dry sand being mixed with it, in either state, to allow the more easy separation from each other; and a third worker followed and levelled the earth, which had been raised up in making the rut, over the seed with the back of an iron garden rake. The sowing was thus conducted quickly, though a sowing-machine that rolls the drills at the same time would be preferable. A roller follows the sowing, and terminates the whole operation.

3387. A difference of opinion exists whether or not the seeds of mangold-wurzel should be steeped in some liquor before being sown. Mr Raynbird conceives they should be sown dry, and, on trying an experiment with steeped and dry seeds, found that 10 of the dry germinated, whilst the largest number of the steeped that appeared was only 6, and these had been steeped in water for 14 hours. I prefer the dry seed, as being safest from the effects of frost and drought, both which may be expected at the season mangold-wurzel seed should be sown.

3388. When the weather is favourable, the plants should make their appearance above ground in 8 or 10 days. The scuffler, fig. 262, is first sent along the drills to pare their sides, and cut down any weeds in the intermediate space; and I may say at once that the entire cleaning process, during the summer, is precisely the same as for the turnip. The plants are hoed out with the hand-hoe, fig. 266, at from 14 to 18 inches apart, according to the strength and rich state of the land; and this is the time to fill up the blanks in the crop, by the transplantation of the best plants which had been singled out.

3389. Mangold-wurzel is raised in rows on the flat surface as well as in drills, and this is chiefly practised on the strongest species of soils, when the manure is ploughed in at the commencement of winter. The seed is dibbled in by hand, or with Newberry's dibbler, referred to above, (3386,) or with a flat piece of wood 5 or 6 feet long, furnished with short dibbles, in the holes made by which the seed is dropped by the hand. In the flat culture sowing with the common dibble, giving it a twist with the wrist to keep the hole open until the seeds have been dropped into it by a field-worker, a man and woman sowing an acre a day, is apt to make the dibble holes in strong soil receptacles for water. But there is no method so good of raising green crops of all kinds as in drills; and if rough clods are dreaded in strong land, let the land be drilled and manured in winter, as has been recommended in the case of raising turnips on strong soils, (3244.) One objection to the flat culture on strong soils seems to me to be insuperable—that the roots are apt to set out lateral shoots, after the soil is set up with the double mould-board plough.

3390. By some experiments instituted by Mr Pusey, on the effects of certain manures on the growth of mangold-wurzel, it would appear that, in doubling farm-yard dung from 13 loads to 26 the acre, only one ton additional was obtained; and that, of various ingredients used, no effect exceeding 5 tons the acre, beyond what had no manure at all, was produced—with the exception of 3 cwt. of guano, and

* *Journal of the English Agricultural Society*, vol. viii. p. 213.

7 cwt. of woollen rags, each along with 13 loads of farm-yard dung, which produced 36 tons the acre. The conclusions at which Mr Pusey arrived are sensible, and are thus expressed:—"The two principal results of the experiment seem to be—that there is in some soils a limit beyond which an additional dose of dung is of no use. This result, if confirmed, would be interesting in theory. In actual farming there is not much danger of our erring in that direction, as to our dressings of dung; and in some parts of the country this would not, perhaps, be a very safe doctrine to dwell upon. The other inference, a more practical one, is, that it is more profitable to use some artificial manures in conjunction with dung, than to use either singly. Thus guano and woollen rags, used singly, added to my crop only 5 tons the acre. The single dressing of dung added only 11 tons, and doubling that amount of dung did no good; but guano combined with the same amount of dung, and rags combined with the same amount of dung, each gave an addition, not of 16 tons of roots, according to their effects when used singly, but of 20 tons, yielding each 36 tons—a produce very large indeed for land which, four years ago, when I took it in hand, was said to be incapable of growing a turnip."*

3391. Like all the succulent green crops, mangold-wurzel is subject to the attack of insects. It was at one time believed that this root was exempt from such attacks, but the experience of the few years bypast has produced an opposite conviction. The mangold-wurzel plant, as soon as it appears above ground, is attacked by the larva of a beetle, named *Silpha opaca*. The eggs are probably laid in the earth—but this remains to be proved—and the larva are hatched in ten or twelve days, and when full-grown are four to five lines in breadth. These are shining black, comprising 13 segments, including the head. They have 6 short legs. From 1844 to 1847 they completely ate down the leaves of the mangold-wurzel in the counties of Londonderry and Tyrone in Ireland; and what is remarkable, the same insect, though abundant in England, does no harm to that crop there. The ultimate effect of these attacks on the mangold-

wurzel leaves is not serious, the crop recovering after the larva have dropped into the ground to be transformed into pupæ, from which emerge the beetles. A very destructive † insect is the common dart-moth, *Noctua* or *Ægrotis segetum*, which is generally of a reddish-brown, but varies so greatly in the tint of the upper wings as to be sometimes of a clay colour. It is in length from 8 lines to three-quarters of an inch, and its expanse is from $1\frac{3}{4}$ to 2 inches. The moth is sometimes seen flying in multitudes about the tops of hedges, soon after sunset, in June and July. The larva is smooth and shining, and of a pale lurid ochreous colour, faintly freckled, with a broad space down the back, often rosy, and a few short hairs scattered over the body. It does great mischief to young mangold-wurzel plants, the roots of which it cuts through just below the crown, and it attacks the potatoes as they are pushing out of the ground, and is exceedingly voracious. One cause of the great mischief arising from the attacks of the caterpillar of this species, is its capability of travelling at a very rapid rate from one spot to another; and in this way, as soon as a caterpillar has eaten through the root of a young plant, it marches off in quest of another, and thus the evil is greatly multiplied. The grub which attacks the oat plant in spring, fig. 223, also injures the mangold-wurzel plant by dividing the young root about an inch below the surface of the ground. Insects which injure the parts of crops under the ground are much more destructive in their effects than those which injure the leaves and buds of plants.

3392. It is not an unfrequent practice to strip off the under leaves of the mangold-wurzel plant in summer, as fodder for cows and pigs; but the practice, as may be supposed, is injurious, as seen from an experiment made by Mr R. Rand, Hadleigh, Suffolk, in 1842. He selected 3 portions of mangold-wurzel, containing each 7 square yards, and from the first portion he stripped 4 or 5 of the under leaves on 8th of July, 6th of August, and first week of September; from the second portion he stripped the same number at each period of the 6th of August and the first week

* *Journal of the English Agricultural Society*, vol. vi. p. 532.

† *Ibid.* vol. viii. p. 407.

of September; and from the third portion none were stript at all. The roots

From 1st portion, 47½ lb. net weight, or			
... 2d ...	52	...	...
... 3d ...	61	...	...

3393. Roots of mangold-wurzel have been grown in Scotland as heavy as 15 lb., and crops obtained of 38 tons to the acre, at Largo in Fifeshire, where the land is of fine quality. From 5 lb. to 8 lb. each root would be near the ordinary mark; but in seasons of late frosts, of which there are too many in Scotland, the mangold-wurzel has no chance of succeeding there.

3394. The plants of mangold-wurzel are very apt to run to seed when exposed to drought early after having been singled out in the rows; and the seed from plants, which had prematurely run to seed, encourages that tendency in the future plant still more than drought.

3395. The mangold-wurzel belongs to the class and order *Pentandria Digynia* of Linnæus; the natural order *Chenopodiæ* of Jussieu; and to *Hy-pogynous Exogens*—alliance 33, *Chenopodales*—order 195, *Chenopodiaceæ*—genus *Beta*, of the natural system of Lindley. Its specific name is *Beta vulgaris campestris*, of the order *Chenopods*, which are closely allied to the Nettleworts. Its leaves are reddish or reddish green; roots thickly fusiform, globular, or spindle-shaped, of a dullish red colour on the outer surface, and marbled white and red of various shades in the interior. One globular variety is of dull orange colour on the outer skin, and another spindle-shaped is similar in colour.

3396. A white variety, called the white sugar beet, *Beta vulgaris campestris alba*, has long been cultivated in France for the sugar which it yields. Many mills are at work in that country for the manufacture of the sugar.† It was the policy of Buonaparte to encourage the culture of this root, in order to render the French people independent of sugar from our colonies. The scheme succeeded in France, but the climate of Britain is unsuited to this delicate root. The physical characters which serve to show that this beet is of good quality for sugar, are its being firm, brittle, emitting a creaking noise when cut, and being perfectly sound within. The degree of sweetness is also a good indication. The 45th degree of latitude appears to be the southern limit of the successful growth of white beet, in reference to the extraction of sugar. Dr Ure states that he has obtained 5 per cent of good sugar from white beet grown near Mitchem in Surrey.‡

were carefully cleaned and weighed, and the produce was as follows:—

14 tons, 13 cwt. 0 qrs. 27 lbs. per acre.			
16 ... 1 ... 0 ... 2 ...			
16 ... 16 ... 2 ... 0* ...			

3397. The German name of the field beet was at one time a matter of dispute, but is now settled to be *mangold-wurzel*, which literally means the root of the white beet. The former phrase *mangel-wurzel* means the root of scarcity, and is used by Von Thäer, in common with the former, to denominate the field beet. His opinion is, that the field beet is a hybrid betwixt the red garden beet and the white sugar beet—a not improbable conjecture.§

3398. Mangold-wurzel seed has a remarkable appearance. It proceeds from a capsule which, when green, is soft and fleshy, and, when ripe, hard, and somewhat woody in texture, and into which the rough kidney-shaped seeds are deeply imbedded. The seeds, with their persistent rough capsule, are so large and heavy as only to require 184 to weigh a drachm.

3399. I have given the composition of mangold-wurzel in (854,) and the ashes of the bulb and leaf, as ascertained by Professor Way and Mr Ogston, contain ingredients as follows:—

1. Of the yellow globe beet.

	Bulb.	Leaf.
Potash,	23.54	8.34
Soda,	19.08	12.21
Lime,	1.78	8.72
Magnesia,	1.75	9.84
Oxide of iron,	0.74	1.46
Carbonic acid,	18.14	6.92
Phosphoric acid,	4.49	5.89
Sulphuric acid,	3.68	6.54
Chloride of sodium,	24.54	37.66
Silica,	2.22	2.35
	<hr/>	<hr/>
	99.96	99.93
Percentage of ash,	<hr/>	<hr/>
	1.02	1.40

2. Of the long red beet.

	Bulb.	Leaf.
Potash,	29.05	27.53
Soda,	19.05	5.83
Lime,	2.17	9.06
Magnesia,	2.79	9.10
Oxide of iron,	0.56	0.48
Carbonic acid,	21.61	6.11
Phosphoric acid,	3.11	4.39
Sulphuric acid,	3.31	6.26
Chloride of sodium,	14.18	29.85
Silica,	4.11	1.35
	<hr/>	<hr/>
	99.94	99.96
Percentage of ash,	<hr/>	<hr/>
	1.00	1.91

* Henslow's *Letters to the Farmers of Suffolk*—Letter xiv.

† *Quarterly Journal of Agriculture*, vol. ii. p. 922.

‡ Ure's *Dictionary of the Arts*—art *Sugar*, p. 1210.

§ Thäer's *Principles of Agriculture*, vol. ii. p. 569—Shaw and Johnston's translation.

3400. Mineral matters in pounds in one ON THE SOWING, AND THE SUMMER TREAT-
ton of MENT OF THE CARROT.

	Mean of three speci- mens of bulb. lb.	Mean of three speci- mens of leaf. lb.
Potash, . . .	4.99	7.86
Soda, . . .	3.02	2.52
Lime, . . .	0.41	3.31
Magnesia, . . .	0.43	3.27
Oxide of iron, . . .	0.12	0.52
Phosphoric acid, . . .	0.66	1.94
Sulphuric acid, . . .	0.65	2.20
Chloride of sodium, . . .	5.29	12.42
Silica, . . .	0.54	0.76
	<hr/>	<hr/>
	16.11	35.20
	<hr/>	<hr/>

3401. "The chief features in the composition of the ash of the bulb, are the large proportion of alkali present in it as carbonates, but existing in the vegetable itself no doubt in great part in the form of nitrates, which are well known to be constituents of beet. Phosphoric acid, sulphuric acid, and lime, are found in the mangold bulb ash in smaller quantity than in that of the turnip. The high percentage of common salt, chloride of sodium, in beet is remarkable: in one case it constitutes one-third, in another one-fourth, of the entire mineral matter. The ash of beet leaves contain more phosphoric and sulphuric acid, more lime and magnesia, but less alkali, and a smaller amount of alkaline carbonate, than that of the bulb. It contains, however, like the bulb, a very considerable quantity of common salt. The ash of both bulb and leaf evidences a partial substitution of soda for potash. Weight for weight, the leaves are considerably richer in phosphoric acid than the bulbs; and they also contain a very much larger proportion of magnesia. The alkalies predominate in the bulb, whilst common salt, although abundantly present in both, is found in larger quantity in the leaf than in that of the turnip."

3402. It may be owing to the effects of the large quantity of common salt contained in mangold-wurzel and turnips, that the milk of cows decreases when fed exclusively on raw mangold-wurzel, or that abortion is brought on ewes in lamb when plied wholly on turnips in winter, and their milk deficient when the lambs are dropped. It is a well-known fact that, when ewes in lamb have been principally fed on Swedish turnips, for some time before the lambing season, that their lambs are small and unhealthy, and themselves are deficient of milk. The effect may arise from the circumstance of the large quantity of common salt contained in turnips diminishing the secretion of the liver, and the effect would be aggravated by a free use of common salt being given to ewes on turnips; and it is, besides, known that incipient disease of the liver is favourable to the production of fat, and hence the high condition of the ewes or lamb on turnips, and especially if salt is attainable at pleasure.*

3403. Although the carrot is a green crop, and occupies the same course of cropping as the turnip, it is raised generally on so limited spaces of ground that it has never assumed the importance of a crop of the farm as its value deserves. Its limited culture may have arisen from certain inconveniences attending its cultivation, such as that it requires a particular kind of soil, very deep ploughing—the dung applied in the unusual season of winter, when the land of the fallow break is not likely to be free of weeds, a second manuring when the seed is sown, and some difficulty attending the sowing of the seed. These are all unusual items of practice, which I have no doubt continue to operate as obstacles against the extended cultivation of even so valuable a root as the carrot. On however small a scale it is cultivated, every particular of the process of cultivation must be attended to as if the crop occupied as large a space as the turnip.

3404. The best soil for the carrot is a deep sandy loam. It will not succeed at all on tenacious soil of any kind, nor one resting immediately upon a retentive sub-soil, whether of clay or rock, and much less if either are undrained.

3405. As the carrot has a long fusiform root, which grows almost entirely under ground, it is evident that it must have a deep soil; and such a depth of soil must either be natural or artificially made so, before the root can be expected to arrive at a perfect proportion of length.

3406. While treating of sea-weed as a manure, I mentioned that it was so used for raising carrots, (2110,) by people in certain parts of the coasts of Scotland, in light sandy soil. This is the mode of raising carrots practised by the feuars of the parish of Barrie, Forfarshire, on sandy soil, and it deserves imitation in similar circumstances. They begin a trench of 2 feet deep in the sand in autumn, after a white crop, and, collecting sea-weed as it is washed ashore after storms in the course

* *Journal of the English Agricultural Society*, vol. viii. p. 185-190.

of winter, they half-fill trench after trench with it, till the break of soil allotted to the carrot crop is manured. Of course other manure would answer the same purpose as sea-ware, but when it can be found in sufficient quantity for the gathering and carriage, it affords a cheap manure for the purpose. Of farm-yard manure, horse-dung is found to be best when treated in this manner as sea-ware is. In the end of April, or beginning of May, ruts are formed with the hoe in rows of about 14 inches apart, and old rotten dung is sown along the bottom of them to insure the braiding of the seed on so poor a soil as loose sand generally is, the seed is sown upon the dung, and the soil raked over it. The plants are thinned out by the hand, at about six inches asunder, and the ground kept clean by hand and hoe together. The carrots grown by the sea-weed in this manner, in loose sand, are not only excellent in quality, but clean, long, and juicy, as may be witnessed in the Dundee market in autumn and winter. The culture in this case is on a small scale, but may be extended to any degree where the circumstances are similar. At the price of £3, or £3, 10s. the ton, and with a crop of not more than 10 tons to the acre, a considerable sum may be annually realised by the labouring and industrious cottar. Instead of rotten dung in the spring, guano might be employed, and in case of injury to the seed from the guano, the seed should be mixed with a quantity of the sand.

3407. The land intended to bear the carrot crop, should be ploughed in the stubble immediately after the harvest is over, to have time to clean it, should it be foul, before the bad weather in winter. As the soil is light, the mode of ploughing it will be by casting, (755,) fig. 22; and, when ploughed, a second plough should follow in the furrow of the one turning over the surface, in order to stir the soil to the depth of 14 or 16 inches. Reid's two-horse subsoil-plough, to be afterwards figured and described, will answer a similar purpose. The land will now be ready for the dung; for the manure for carrots must be put into the ground before winter, the nature of that root not agreeing with fresh dung, which causes it to divide into a number of roots, each so fibrous as to be unfit for use. The dung

should be applied in drill; and as it need not be much reduced by fermentation, the drills should be deep, and formed in the double mode, (2397.) The quantity applied should be 25 tons to the acre. After the dung has been covered in the double mode again, the land remains in that state until next spring.

3408. About the end of April the seed is sown, and carrot seed should always be steeped in water before being sown, and it is steeped in this way: The bag containing the seed, which should be in the quantity of 6 lb. of the best quality to the acre, and an indefinite number of pounds more when of doubtful soundness—which it will certainly be if older than one year—is placed in a vessel of water and allowed to soak for 48 hours; and this process should be gone through eight or nine days before the seed is sown. After the soaking, the seed is spread about a foot in thickness upon the barn floor, to encourage its germination, which will take place in six or seven days, according to the state of the weather. When the seed is observed to be chipped it should be sown, and it is prepared for sowing by being intimately mixed with fine dry sand to about 4 pecks to the acre, seed and sand together.

3409. About the middle of April, should the drilled ground bear evidence of surface weeds, the drill-harrow, fig. 220, should harrow along the drills, and the drill-grubber, fig. 264, remove the weeds between the drills. At this time, 2 cwt. of guano should be carefully sown by hand along the top of the drills. The setting up double mould-board plough, fig. 214, should place the mould again upon the drills, and give them again their proper form; and a light roller, such as the concave rollers of the turnip sowing-machine, fig. 254, without the coulters, will make the tops even and smooth. The seed should be preparing in the steeping and germinating processes, to answer the time of these last operations; and the large quantity of sand with which it is mixed will protect it from immediate contact and injury from the action of the guano.

3410. I have never yet seen a properly constructed machine for sowing seeds with rough capsules, such as those of mangold-

wurzel and carrot; but as carrot seed is mixed with so large a quantity of fine sand, I dare say the sowing part of the bean-barrow, fig. 219, might be so adjusted as to answer the purpose. Failing any machine, a rut should be made along the top of each drill with the corner of the hand-hoe, fig. 266; the seed and sand sown by hand in the rut, and covered with the earth raised by making the rut about an inch in depth, with light iron rakes. The rollers of fig. 254, on being again passed along the drills, finish the operation.

3411. The varieties of carrot cultivated in the field need not be numerous, as one or two kinds are all that are desirable. The white Belgian carrot now stands at the head of all the varieties for certainty of crop, beauty of root, and sweetness of taste. It is not long,—thick at the crown, and tapering to a point. It grows wholly under ground. The Altringham is a good carrot—long, blunt in the end, rather irregular in its taper, and of an orange tinge in its colour. It grows a considerable height above the ground. The long red is also a good carrot, of a deep red colour, long in proportion to its thickness, and has a comparatively small heart.

3412. The use of the guano is to start the seed and support the young plant, until its long root reaches the dung below, which it will not be long in doing. The young germ will appear above ground in from twenty to twenty-five days, and when it is about an inch in height, it is time to single out the plants to 6 inches apart in the drill, which is best done by the hand, in the case of the long-rooted carrot. Scuffling, fig. 262, and drill-grubbing the ground between the drills, fig. 264, to make the land clean and to stir it, are executed in precisely the same manner as for turnips.

3413. Besides light true soils, carrots are successfully raised on reclaimed bog that has some alluvial matter in it. The culture is the same as on earthy soil, the manure being deep buried; and as dried moss is very porous in texture, the carrot is enabled to push its long root through it with comparative ease.

3414. Carrots may be raised in rows on the flat ground, but unless the soil is

naturally deep and rich, and loose, this mode of culture is not so well suited for the field as that in drills; for with deep-ploughing to any extent, there is no possibility of burying dung so deep, and affording the crop such a depth of soil, as in the drill—and both these conditions are essential to the successful cultivation of the carrot.

3415. Carrots are also sown broadcast, upon the flat surface; but, excepting in very small patches, this mode of culture is not suited to the use of implements of the field, and the clearing of the ground of weeds must therefore be expensively executed by the hand.

3416. Insects infest the carrot crop in the root, stem, and flower. The plant no sooner makes its appearance than it is attacked by aphides, the *Aphis dauci*, which are scarcely larger than cheese mites, of a uniform pale green colour, with 6 legs, 2 horns, and no wings. Their presence is indicated by the yellow foliage, and, in pulling up the plant, the roots are sound and clean, but the crown is not only discoloured, but, on opening the embryo leaves, numbers of the aphides are found concealed.

3417. The root of the carrot is affected with a disease named the *rust*, in which the crop gradually dies off, loses its saccharine qualities, and, changing to a ferruginous colour, becomes of little value. This complaint is occasioned by the larvæ of the carrot-fly, *Psila rosæ*, eating galleries along the roots which they inhabit through the summer, when they become pupæ in the earth, but a new brood hatches in summer every three or four weeks. This fly is 3 lines long, of a pitchy black; the wings lie horizontally along the back when at rest, and extend beyond the tail, and when expanded extend to 5 lines. The maggots are ochreous and shining, cylindrical, pointed at the head and obtuse at the tail, resembling cheese-hoppers, though they cannot leap, and are exceedingly transparent, every internal part being visible. When cavities have been opened by this maggot in the rest of the carrot, large numbers of the millepede, *Polydesmus complanatus*, and of the centipede, *Scolopendra electrica*, assist in extending the depredations. Another caterpillar, the larva of the ghost-

moth, *Hepialis humili*, also eats into the root of the carrot and injures it.

3418. Mr Curtis gives the recipe of a composition of sand and spirit of tar, to prevent those insects injuring the carrot root. Take 4 bushels of sand and mix intimately with them one gallon of the spirit of tar. The mixture is to be applied along the drill, and if a space of half a foot in breadth upon the top of the drill is dressed with it, the quantity named will dress about 1300 yards along a drill. If it is applied in the drill when that is formed in winter, the spirit of tar may kill the young larvæ in the soil; if in spring, the female fly may be deterred from depositing her eggs, and it will no doubt be as successful when the crop is sown, as it is the smell of the spirit of tar which is the obnoxious ingredient to insects. As carrots are not cultivated over a large extent of ground in any one place, this remedy may be easily applied, both as regards its cost and the ease of its application.

3419. The larvæ of the flat-body moths, *Depressaria cicutella* and *depressella*, bore into the stems of the carrot, causing the leaves to stint and decay; and the larvæ of the gray carrot-blossom flat-body moth, *Depressaria daucella*, commit great havoc on the floral umbels of the carrot.

3420. Few agricultural seeds are so difficult to obtain in a good state as those of the different varieties of the carrot; and this is partly to be ascribed to the injuries occasioned by this insect, and greatly also to a wet state of the weather, the form of the umbels being favourable to the retention of much moisture, which either prevents impregnation altogether, or destroys the vitality of the seed. Of all the varieties, the seed of the Altringham is the most difficult to obtain pure, for though obtained from selected roots, its produce is often unlike the parent stock.

3421. Altringham carrots have been grown at Falkland in Fifeshire, of crop 1834, that have weighed 5 lb. each. In good hazel loam, on the home farm of Blair-Drummond in Perthshire, 29 tons of carrots have been obtained from the acre; but from 16 to 20 tons are a good crop. It is said generally that the produce of the

white Belgian carrot is 9 or 10 tons the acre greater, in the same circumstances, than that of the red varieties. In Belgium the produce of the white carrot is 160 bushels the acre, the individual carrots weighing $1\frac{1}{2}$ lb., making the crop about 4 tons the acre, raised with 21 tons of manure, half of farm-yard dung and half from the privies.

3422. Hares and rabbits are so fond of the carrot that, unless the crop is protected where they abound, it will have a poor chance of coming to maturity; and unless the fence erected round the crop is a close one, it will not be able to exclude these wily depredators. I believe the only effectual fence is a close paling of laths pushed into the ground, supported near the top and bottom with horizontal spars nailed to them, and the whole held steady by stobs driven at intervals into the ground to act as shores against the paling. If a common 3-sparred paling already exists, it might be made fencible by interlacing stems of broom, or whin, or branches of spruce fir, between the spars. A dead fence of thorus also forms a complete fence.

3423. On account of the land for carrots having to be cleaned and manured before winter, the culture of that root is not likely to be extended in Scotland, where the harvest is not unfrequently late, and little time left for cleansing operations after it. It is true that, should the potato crop occupy a less extent of ground in future than it has hitherto done, the time that would be saved from attending on that crop might be bestowed on the carrot in the end of autumn, and it would thus come in for a share of attention which it has not hitherto received. Both it and mangold-wurzel requiring to be taken up and stored in autumn, (836-37-38,) wheat would follow them. Trivial as the circumstance may appear of the partiality which hares and rabbits exhibit for the carrot, it will continue to operate as an obstacle to its extended cultivation, for the trouble of fencing in the crop so closely cannot be generally practised.

3424. Notwithstanding these considerations, I have dwelt the longer on the culture of the carrot, as it is a root suited to the

climate of Scotland, on which account it may take the place of the potato, the culture of which cannot now be pursued with the same degree of confidence it has hitherto received.

3425. The carrot stands in the class and order *Pentandria Digynia* of Linnæus; in the natural order, *Umbelliferae* of Jussieu; and in *Epigynous Erogenæ*—alliance 55, *Umbellales*—order 295, *Apiaceæ*—tribe 12, *Daucidæ*—genus *Daucus*, of the natural system of Lindley.

3426. Umbellifers are “natives chiefly of the northern part of the northern hemisphere, inhabiting groves, thickets, plains, marshes, and waste places. They appear to be extremely rare in all tropical countries, except at considerable elevations, where they gradually increase in number as the other parts of the vegetation acquire an extra-tropical or mountain character. Hence, although they are hardly known in the plains of India, they abound on the mountains of Himalaya. They are, however, not uncommon in the southern hemisphere, where they belong principally to hydrocotylids and malinids. The umbelliferous is one of those large orders in which plants occur with extremely different secretions. They all appear to form three different principles: the first, a watery acid matter; the second, a gum-resinous milky substance; and the third, an aromatic, oily secretion. When the first of these predominate, they are poisons, as the hemlock; the second, in excess, converts them into stimulants, as the assafoetida; the absence of the two renders them useful esculents, as celery, fennel, samphire, parsley, and the roots of carrots, parsnips, and skirrets; and the third causes them to be carminatives and pleasant condiments, as anise, carraway, coriander, and cummin, used in veterinary practice.”*

3427. The carrot, *Daucus carota*, has white flowers, with a solitary red or purplish barren one in the centre of the umbel; bristles of the seed slender, and as the same becomes ripe, the umbel acquires a contracted and concave form; leaves tripinnate; leaflets, pinnatifid; stems, rough and furrowed; root, fleshy and fusiform, biennial. The generic name, *daucus*, is derived from the Greek, signifying hot, implying pungency; and the specific term *carota*, is from the Celtic *car*, meaning red, the colour of the root.

3428. The composition of the carrot has been given in (854). The proportion of water in the carrot is as follows:—

Water,	Young red carrot.			Old red carrot.		Old white carrot.	
	roots.	leaves.	stems.	roots.	tops.	roots.	tops.
	87.98	76.63	87.58	80.21	75.97	80.23	74.16

3429. The ash of the root of the carrot is as follows, from two authorities:—

	JOHNSTON.		WAY AND OOSTON.
	Young red carrot.	Old red carrot.	White Belgian carrot—mean of 5 specimens.
Potash,	46.37	46.87	32.44
Soda,	12.92	8.12	13.52
Lime,	15.38	6.58	8.83
Magnesia,	2.12	9.06	3.96
Oxide of iron,	0.90	0.37	1.10
Phosphoric acid,	4.65	10.48	8.55
Sulphuric acid,	8.09	6.30	6.55
Carbonic acid, . . . .	..	..	17.30
Chloride of sodium,	6.43	10.62	6.50
Silica,	3.14	1.62	1.19
	100.00	100.02	99.94

The carrot is rich in alkalies, much resembling the turnip—the latter yields more sulphates, the former more carbonates.

3430. The ash of the leaves contain:—

	JOHNSTON.		WAY AND OOSTON.
	Young red carrot. Stems.	Leaves.	White Belgian carrot—mean of 3 specimens. Leaves.
Potash,	48.50	19.08	27.04
Soda,	4.53	5.80	7.12
Lime,	18.58	34.10	26.53
Magnesia,	2.04	4.48	32.64
Oxide of iron,	1.46	2.40	2.92
Phosphoric acid,	3.36	8.17	2.40
Sulphuric acid,	5.05	14.54	7.75
Carbonic acid, . . . .	..	..	6.20
Chloride of potassium, . . . .	..	..	17.82
Chloride of sodium,	14.54	9.33	5.04
Silica,	1.94	2.10	13.67
	100.00	100.00	100.00
			99.97

“The ash of carrot-leaf is peculiar in one respect,” observes Professor Way: “of the alkalies, potash, and soda, the latter greatly predominates. This is, in reality, an important as well as a singular circumstance. The alkali soda is much more available for agricultural purposes than potash, especially as the results we have obtained would induce a belief that a plant can obtain this alkali from common salt—the commonest of all salts. If any plant be found to content itself with this alkali, such plant will undoubtedly be more easy of artificial culture than others which require potash, and refuse to take soda instead of it: it is not said that this is the case with the carrot, but attention is drawn to the uniformity of the result in the case of the leaves.”

3431. Mineral matter in one ton of carrot-roots and of leaves, in pounds:—

	Mean of five specimens.	
	Roots.	Leaves.
Potash,	6.59	6.64
Soda,	2.71	9.67
Lime,	1.77	30.24
Magnesia,	0.80	2.51
Oxide of iron,	0.22	2.76
Phosphoric acid,	1.73	1.64
Sulphuric acid,	1.21	5.61
Chloride of sodium,	1.42	11.95
Silica,	0.24	4.46
	6.79	75.14

* Lindley's *Vegetable Kingdom*, p. 775.

† *Transactions of the Highland and Agricultural Society*, for July 1847, p. 67-68.

Although the ash in the leaf is greater than in the root, and varies much more greatly in the different specimens, yet in the entire plant the mineral matter will be found far more constant in quantity and composition, than in either the root or the leaf taken separately; the variations which occur being counteracted by the alteration of the percentage of ash, or of the proportion of root to leaf.*

3432. A mode of raising the carrot is practised in Belgium which we would consider slovenly and expensive. The seed is sown broadcast with the last turn of the harrows, with a cereal crop in spring, and when the crop is harvested the carrot has acquired a very moderate growth, and the land is weeded by hand and the stubble also removed, the field-workers going down on their knees and wearing a peculiar dress for the purpose, no fewer than 20 weeders being required to the acre. The produce is about half of the regular crop. Each horse is allowed 25 lbs. of carrots a day without hay, and cows receive the same quantity, upon which they yield good butter both as to quantity and quality.†

3433. The farmer may raise as much carrot seed as to supply his own wants. The largest and best roots are inserted in some convenient piece of ground in October or November, or in the end of February, in rows 27 inches apart, as deep as to have two or three inches of earth over their crowns. The only care required during the summer is to keep the ground clean, partly by hand-hoeing and drill-grubbing, fig. 264. The seed will be ripe in autumn, and as birds do not disturb it, the crop does not require to be watched. Gather the seed only from the principal umbel of each plant, which will not only afford the ripest and largest seed, but the most vigorous plants. The umbels are very liable to be affected with mildew in damp weather. The yield of seed may be expected to afford from 1½ lb. to 5 lb. per rood of 16½ feet square. A considerable quantity of carrot seed is raised for the London market, near Weatherfield, in Essex.

3434. Much carrot seed is annually imported from Holland, and, by the tariff of 1846, it pays a duty of 5s., and when from any British possession, 2s. 6d. the cwt.

ON THE SOWING, AND THE SUMMER TREATMENT OF PARSNIP.

3435. The parsnip requires a milder climate than Scotland generally affords; but it grows well in England, and in perfection in the island of Jersey, both as regards the quality of the root and the weight of the crop.

3436. It will grow in a much stronger soil

than the carrot, and yet it may be raised upon sand, and even peat, if sufficient manure be applied.

3437. Its culture should be precisely that of the turnip and the carrot, being a green crop in the fallow division of the farm, and requiring a deep soil for the growth of its fusiform roots. This root, however, is not impatient of immediate contact with manure like the carrot, so that the land may be drilled and dunged in spring instead of winter, as is done for the carrot. Parsnips should receive 25 tons of farm-yard dung in the drill, and 4 cwt. of guano sown over the dung, as described for the turnip crop, (3239,) and the land then drilled up in the double form, (2397,) or with the setting-up double mould-board plough, fig. 214; though it is improbable that this plough is able to cover so much manure as the carrot and parsnip require.

3438. Parsnip seed is contained in a broad thin capsule, and is very light. Even when good, 10 lb. will be required for the acre. Care should be taken that it be fresh and new. It should be steeped in water before it is sown, as it would otherwise lie long in the ground before it would germinate; but after being soaked, if sown in very dry soil, it is apt to be deprived of its vitality. The sowing-machines at present in use are not well adapted for the sowing of this seed any more than that of the carrot and the mangold-wurzel; but on being mixed with sand, after being soaked, it may be sown in the rut, made in the top of the drill with the corner of the hand-hoe, fig. 266, or with the bean-drill barrow, fig. 219; but it would be more expeditiously sown in the rut, out of the bands of two or three workers, than with that machine. Rakes cover the seed with soil very well, and a rolling with concave rollers of the turnip-sowing machine, fig. 254, without the coulter, finishes the sowing of the crop in a neat manner.

3439. Parsnips should be singled whenever the plant can be discriminated. The scuffler, fig. 262, clears away the surface weeds in the first instance. The singling is made at a distance of 8 inches apart in the drill—the stems and leaves, spreading

* *Journal of the English Agricultural Society*, vol. viii. p. 192-6.

† Radcliffe's *Agriculture of Flanders*, p. 76.

more than those of the carrot, require more room. The after-hoeing and cleaning of the land of the weeds with the drill-grubber, fig. 264, are conducted in the same manner as those for the turnip and carrot. The drill should be set up with the double mould-board plough, fig. 214, to heap the earth as much about the root as possible, as in the case of the carrot.

3440. The parsnip may be raised in rows in the flat ground, as well as the carrot, but the same reasons given for the culture of the carrot in the drill (3314) will apply to that of the parsnip. Colonel Le Couteur describes the broadcast mode pursued in Jersey in the following terms:—“An old grass lea is broken up by some persons in September, by others just before the parsnip-land is sown. The former I consider to be the best mode. When the turf is well rotted, 20 tons of stable manure per acre are spread over the land. A trench is then opened through the centre of the field, between 2 and 3 feet wide, and, where the soil will admit of it, from 1 foot to 18 inches deep. A 2-horse plough then turns the manure and about 3 inches of soil into the trench, and is immediately followed by a large trench-plough with 3 or 4, and in many cases here, with 8 or 10 horses, which turns one foot or more of clean soil upon the manure and turf, when the land has been recently skim-ploughed. The soil is then harrowed, and the parsnip-seed, quite *new*, is sown at the rate of 3 or 4 lb. to the acre, and lightly harrowed. When the plants are one inch high, they are weeded. The plants, from the first, should be thinned out to 6 inches apart, and, according as the soil is good, should be again thinned out to 9 inches or more at the second hoeing. In a dry season it is well to observe that moistening the seed with wet sand and earth, and stirring it daily, to be sown in the first moist weather, or after a shower, will forward its growth a fortnight.” I may observe that this method of cultivating any green crop does no credit to Jersey agriculture. Just conceive a green crop taken after lea—8 or 10 horses being employed in a trench-plough—the land dunged before being trench-ploughed. But notwithstanding this objectionable mode of culture, which

violates every rule of good husbandry, such is the nature of the climate that the crop yields 27 tons and upwards the acre—a quantity, Colonel Le Couteur states, which is “nearly sufficient for 10 cows during the 6 winter months, according to the calculation of the Flemings.”*

3441. The parsnip is subjected to the attacks of a few insects. The maggots of the parsnip miner, *Tephrites onopordonis*, are hatched from May to July, and feed upon the parenchyma or pulp of the leaf, causing large blisters upon them; and when two or three larvæ are feeding on the same leaf, the blisters unite and form large discoloured patches, but otherwise the mischief is not serious. The caterpillars of the flat-body moth, *Depressaria pastinacella*, infest the parsnips left for seed, and often much injure and diminish the yield. They prefer the parsnip to the carrot seed, and on this account the growers of carrot seed sow some parsnips beside them, by which to lure the insect from the carrot crop. These caterpillars are grayish blue, with the head, thorax, and pectoral feet, black; upon each of the segments are 6 distinct little black dots, producing single minute hairs; the sides and the belly are yellow, and the abdominal feet are dotted with black. They live in July upon the flowers and young seeds of the parsnip. There seems to be no better mode of ridding parsnip crops of these caterpillar pests than hand-picking, and shaking the umbels of the flowers over a vessel for them to fall into. The flower of the parsnip is not nearly so liable to be affected by insects, damp, or mildew, as the carrot, on which account the crop of seed is a surer one—though it should be borne in mind that it will not retain its vitality beyond one year.†

3442. It is quite easy to raise as much seed of the parsnip as is required on any farm. Transplant some of the best roots in a spade-dug piece of ground in February, at 2 feet apart in every direction, and insert them with their crowns under the surface of the ground. The ground should be kept clean with the hand-hoe until the leaves of the plants cover the ground. The shoots will become strong stalks, and produce

* *Journal of the English Agricultural Society*, vol. i. p. 419.

† *Ibid.* vol. ix. p. 190-4.

large umbels of seed, which will ripen in autumn. From 1½ lb. to 4 lb. of seed, being very light, may be expected from a square rood of 16½ feet, dependent on the nature of the season, and escape from the attacks of insects. Birds do not injure it, though, if the seeds are not gathered from the umbels as they ripen, they are very apt to be blown off by the wind.

3443. I have seen a statement of the expense of cultivating an acre of parsnips, and the return obtained from it in 1847 upon the Cappoquin home farm in Ireland, belonging to Sir Richard Keene, Bart. The cost of cultivating the imperial acre, including trenching 16 inches deep with the spade, ploughing into drills of 27 inches apart, manuring with 40 tons of farm-yard dung, singling, hoeing, weeding, rent, taxes, and planting 400 cabbage plants in the spaces which failed, was £11, 15s. 4d. The return was 20 tons of parsnips the acre, which were sold in Cappoquin market at 4d. the stone, or £2, 13s. 4d. the ton, amounting to £53, 6s. 8d., and the cabbages fetched £3, 6s. 8d., at 2d. a-piece, averaging 14 lb. each in weight. After deducting the cost, the sum realised from the acre was £44, 18s.

3444. The parsnip is placed in the class and order *Pentandria digynia* by Linnæus; in the natural order *Umbellifera* by Jussieu; and in the natural system of *Epigynous Exogens*—alliance 55, *Umbellales*—order 295, *Apiaciæ*—tribe 8, *Peucedanidæ*—genus *Pastinaca*, by Lindley.

3445. The parsnip, *Pastinaca sativa edulis*, has leaves pinnate or compressed, downy beneath, and generally shining above; leaflets broadly ovate, cut, and serrated, terminative, three-lobed; colour of the flower yellow; root fleshy, thick, and fusiform; biennial. It derives its generic name from the form of the root being like a dibble, *pastinum*. This root has long been an inmate of the garden, and was formerly much used. In the times of Popery it was the farmer's Lent root, being eaten with salted fish, to which it is still an excellent accompaniment. "In the north of Scotland," Dr Neill observes, "parsnips are often beat up with potatoes and a little butter; of this excellent mess the children of the peasantry are very fond, and they do not fail to thrive upon it. In the north of Ireland, a pleasant table beverage is prepared from the roots, brewed along with hops. Parsnip wine is also made in some places; and they afford an excellent ardent spirit, when distilled after a similar preparatory process to that bestowed on

potatoes destined for that purpose."* It is an excellent food for cows, and its fattening properties I have already noticed in (896.)

3446. Parsnips are cultivated in the drill method in Jersey as well as the broadcast, as thus described by Colonel Le Couteur. "The land," he says, "may be prepared as in the broadcast method. In one case I found the plants to answer well by spreading a portion of the manure on the surface of the ploughed land, and then earthing it up into small ridges, one foot apart, with a double mould-board plough. The seed is then sown on the top of the ridge and rolled in, which succeeded extremely well. The hoeing was performed with a horse-hoe in the drills, and the plants were cross-hoed with a hand-hoe. This mode does not appear so neat as the following: when the land is well harrowed and levelled, sow the seed broadcast, harrow and roll it; then when the plants appear, hoe it into drills, either with a horse-hoe or hand-hoe. A drill-machine will be the best method if one could be found to sow parsnip seed regularly; mine sows it much too profusely. The parsnips require hoeing and thinning as in the broadcast husbandry."† It seems strange practice to us to convert a crop into rows by sending an implement through a broadcast braird.

3447. The composition of the parsnip root I have given in (854.) and the composition of the ash, whether of the root or the leaf, has not yet been ascertained by the chemist.

ON THE SOWING, AND THE SUMMER TREATMENT OF RAPE.

3448. Rape is cultivated in this country, not for its seed, as is the case on the Continent, but for its leaves as a forage plant, and a more wholesome food for sheep is not raised on the farm.

3449. It may be raised to be consumed at two different seasons—autumn and spring. To be consumed in autumn it should be sown in summer, and for spring consumption it should be sown in autumn. The culture up to the sowing of the seed, in either case, is precisely the same as for turnips. In England, in the richer soils, it is sown without manure; but in Scotland the crop would not repay the trouble were it attempted to be raised without manure, though it does not require the same quantity of farm-yard dung as the turnip; 10 tons the acre being sufficient to raise a good crop, or 16 bushels of bone-dust, or 4 cwt. of guano—the

* Don's *General System of Gardening and Botany*, vol. iii. p. 354.

† *Journal of the English Agricultural Society*, vol. i. p. 420-1.

manures being applied respectively as directed for turnips.

3450. The culture of this plant ceases after the sowing of the seed, as the crop is not thinned out like turnips or the other rooted green crops, the object being to raise a sufficient number of stems to produce a large crop of leaves, for which purpose 2 lb. of seed to the acre will suffice; and as the seed is large compared to that of the common turnip, and about the size of that of the swede, that quantity will not produce too many plants to stand in the drill. Rape seed affords 810 seeds to one drachm, and weighs about 53 lb. to the bushel. The turnip sowing-machine, fig. 254, is used for sowing the seed, using one of the larger-sized holes in the seed-box. When weeds make their appearance before the plants are sufficiently advanced in height to keep them down, the scuffer, fig. 262, drill grubber, fig. 264, and double mould-board plough, fig. 209, must be put in requisition to remove them, and place the ground again in its proper form and state.

3451. Rape will grow on almost any soil, and certainly well on clay, on which it requires less manure than on hard loam; but it grows on none so well as on drained moss resting on a clay subsoil. The ashes of the surface of a peat-bog, pared and burned, form excellent manure for rape on drained moss.

3452. Rape is raised to be consumed by sheep, by folding on the land, as a mode of manuring fallow ground. This is a common practice in England, for the double purpose of manuring the soil and fattening sheep; and to attain both ends the rape seed is sown in May, and the crop is ready for being folded on in July or August.

3453. In Scotland, sheep are never fattened on rape, the crop being appropriated to ewes, to bring them into season for the tup, and to hogs in preparation for turnips. For these purposes it is not necessary to sow the rape seed until the beginning of July, after the termination of the turnip seed at the end of June, which

renders the culture of rape both convenient and useful.

3454. In the progress of growth, the rape is attacked by insects. The green veined white butterfly, *Pontia napi*, is so named because it feeds chiefly upon the rape. The superior wings have tips of powdery black, and the nervures grayish, inferior wings have a black spot on the upper margin, and the dark nervures shining through. Caterpillars are delicately green, clothed with velvety hairs. The male butterflies are nearly three-quarters of an inch long. The larva of this species is destroyed by the ichneumon, named *Hemiteles melanarius*. Hand-picking, and young fowls to pick up the larvæ as they are switched off the plants, is the most easy mode of getting quit of them.

3455. Sheep are very fond of rape as food; and that it is nourishing food the experience of every farmer who has cultivated it can testify. By an experiment made on Barteliver farm in Cornwall, it appears that 14 acres of rape, sown at three periods, from 13th May to 10th July, supported 80 sheep from the 2d of July to the 2d of November. On the 10th of August, 10 wether hogs of those sheep were weighed, and they were 146 lb. each, and on the 21st September they were again weighed and were then 166 lb. each, making an increase of weight of 20 lb. in six weeks—that is, an increase of 10s. a-head in 6 weeks, at 6d. the lb.*

3456. The rape is placed by Linnæus in the class *Tetradynamia*; in the natural order *Crucifera* by Jussieu; and in *Hypogynous Erogens*—alliance 27, *Cistales*—order 123, *Brassicæ*—tribe 3, *Orthoplonæ*—genus *Brassica*. The rape is *Brassica napus*, the botanical characters of which are leaves smooth, of a grayish-glaucous hue, radicle ones lyrate, stem ones pinnatifid and crenated, uppermost ones cordate lanceolate, clasping the stem; siliques devaricate spreading. Native country not known. This species of rape is well suited for culture in winter, and is allied to the common turnip in its nature.

3457. The rape of the Continent is *Brassica campestris olifera*, or *colza*, a variety of cabbage allied to the Swedish turnip, and is best suited for summer culture. It is distinguished from the other rape by its leaves being hispid, those of the other being smooth. Its produce also, when

* *Journal of the English Agricultural Society*, vol. vi. p. 430.

compared to the other, is greater by 955 to 700 according to Gujac.*

3458. The colza is cultivated in Mecklenburg and Holstein for its seed, out of which is expressed rape oil, used for the purposes of illumination and in manufactures. In Holstein the crop of seed is great, being 4000 lb. the acre, or nearly 36 cwt., which yields from 40 to 70 per cent of oil.

3459. The cake left on the expression of the oil from the seed is called *rape-cake*, and is more used in this country as a specific manure than for feeding. Its price is from £4, 10s. to £5, 10s. the ton, and is free of duty on importation.

3460. Rape-cake, when subjected to chemical analysis, yields the following constituents, according to Dr Henry R. Madden:—

Organic matter,	{	Water,	10.5	10.5
		Soluble in cold water,	24.7	
		in hot water,	4.8	85.5
		in weak potass,	31.5	
		in strong potass,	10.2	
		Destroyed by heat,	14.3	
		Earthy phosphates,	3.0	4.0
		Silicate of potass,	1.0	
			100.0	100.0†

3461. The quantity of rape seed imported in 1847 was 47,523 quarters, and in 1848 it was 129,967, free of duty. The rape-cakes imported in those years were included in the returns of oil-cakes imported, as stated in (3126.)

3462. The plants enumerated from the bean to the rape, are those usually cultivated on a farm: not that any one of these plants are cultivated every year upon the same farm, for space might not be found in some farms for the cultivation of so large a variety of plants; and it is improbable that any farm contains so diversified a soil as to permit the cultivation of such a variety of crops. Beans and turnips cannot be cultivated to a large extent on the same farm, the soil best suited to the former being ungenial to the latter. Nor is it convenient to sow a large breadth of turnips and of rape in the same season. Should the weather prevent the sowing of turnips in their proper season, it would be more prudent to employ the labour and manure allotted for them to raise rape a few weeks after the turnip season, to be consumed by the stock in late autumn or early winter, when cows are as fond of rape as sheep are, than to attempt to raise turnips too late. In choosing, therefore, the various crops enumerated and described above, those should be selected which are best suited to the soil to be cultivated, and to the weather which may prevail at the season when the state of the work is ready to undertake the sowing of a crop.

ON THE SOWING, AND THE SUMMER CULTURE OF BUCKWHEAT.

3463. Poultry and pigs were greatly

supported on the potato, as long as it was available for the purpose; but now that no implicit confidence can be placed on that crop, and in consequence it will in future fetch a large comparative price, it will be prudent in the farmer to consider what plants may be substituted for it in supporting these useful races of live stock, with wholesome food, at a reasonable cost. Fortunately there are other plants which may be employed for the purpose. Buckwheat, *Polygonum fagopyrum*, makes excellent food for pigs; the seeds of the common sun-flower, *Helianthus annuus*, fatten poultry; the madia, *Madia sativa*, is favourably spoken of on the Continent, for the same purpose; and the dwarf varieties of the Indian corn or maize, *Zea mays*, are capable of supporting the horse as well as the fowl. Whatever may be the results attending the cultivation of these plants, a trial of one or more of them, by way of experiment, should be made in many localities of Scotland; and then perhaps, ere long, they would become naturalised to the climate.

3464. Buckwheat is not well suited to the variable climate of Britain. It possesses the advantage of growing best on sandy soil, which is too poor to carry barley, and in such heat and drought as are too great for oats to bear. In the circumstances of heat and sandiness of soil, then, it might be cultivated where no cereal grain would grow; and on the light soil of a farm, in a sheltered situation, it might be attempted, especially on new trenched ground, without manure, in preparation of a green crop. Much manure would encourage the growth of the plant, and prevent the formation of seed. This plant is very impatient of frost, and, were it sown as early as to appear above ground before frost had left for the season, the crop would inevitably be destroyed. It should, therefore, not be sown sooner than the last week of May in England, and of June in Scotland: and late sowing is in no case unfavourable to the plant, as it grows quickly, and produces its seed in the principal part of the flower in September. The land is very easily cultivated for buckwheat. Having been ploughed in winter, from the oat stubble, by casting

* Don's *General System of Botany and Gardening*, vol. i. p. 242.

† *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 529.

the ridges together, (755), fig. 22, it should be cross-ploughed (2613) in spring, harrowed, and picked free of weeds, after which recast, and again harrowed and hand-weeded. As abundance of time will be found to clean the land thoroughly before the time arrives for sowing the seed, it may be ploughed in any way thought most expedient, should the land show symptoms of foulness; but, if not, a passage of the grubber, fig. 215, will prevent the surface weeds becoming troublesome. From 1 to 2 bushels of seed are sufficient to the acre, and is always sown broadcast, though sometimes recommended to be drilled in rows at 12 inches apart. After the seed has been sown and harrowed in, the crop requires no further care until the harvest. The land should be cultivated for a green crop after the removal of buckwheat.

3465. Buckwheat stands in the order *Octandria Trigynia* of Linnæus; in the natural order of *Polygonaceæ* of Jussieu; and in *Hypogynous Exogens*—alliance 37, *Silicales*—order 191, *Polygonaceæ*—tribe 2, *Polygonaceæ*—genus, *Polygonum*, of the natural system of Lindley. The character of this family of plants is, that while the leaves and young shoots are acid and agreeable, the roots are universally nauseous and purgative; and to these are added a third—that of astringency.

3466. "Buckwheat, *Polygonum fagopyrum*," *Fagopyrum esculentum* of Tournefort, "is said to be found wild in Persia," observes the late Rev. Mr Rham. "The cultivation of it, according to some authorities, was introduced into Europe by the crusaders; according to others, the Moors introduced it into Spain from Africa; and hence it has in France the name of Bled sarrasin. The name of buckwheat is a corruption of the German buch-weizen, which signifies beechwheat, from the resemblance of the seed to that of the beech-tree. It is called wheat because, when ground, it produces a fine farina, which resembles that of wheat in appearance. The botanical name of the genus, *Polygonum*, is taken from the angular form of the seed, and the specific name, *fagopyrum*, from its resemblance to the beech-mast. Buckwheat grows with a strong herbaceous, cylindrical, and branching stem of a reddish colour, about 2 feet high. The leaves, which are ivy-shaped, are placed alternately on the stems. The flowers grow in bunches at the end of the branches, and are succeeded by black angular seeds, formed of four triangles, being thus nearly regular tetrahedrons. The plant is an annual, and the flowers appear very soon after it is out of the ground. They continue to blow

and bear seed in succession, till the frost destroys the plant."*

3467. This plant has not yet been satisfactorily examined by chemists: the composition of its green stems, according to Crome, is—

Water,	82.5
Starch,	4.7
Woody fibre,	10.0
Sugar, . . . . .	...
Albumen,	0.2
Extractive matter and gum,	2.6
Fatty matter,	?
Phosphate of lime,	?
	<hr/>
	100.0
	<hr/>

3468. The composition of the seed of the buckwheat, according to Zennick, is this, but which is evidently imperfect—

Husk,	26.9
Gluten, &c.	10.7
Starch,	52.3
Sugar and gum,	8.3
Fatty matter,	0.4
	<hr/>
	98.6
	<hr/>

3469. The ash of the seed of the buckwheat, according to Bichau, consists in the following proportions of the ingredients:—

Potash,	8.74
Soda,	20.10
Lime,	6.66
Magnesia,	10.38
Oxide of iron,	1.05
Phosphoric acid,	50.07
Sulphuric acid,	2.16
Silica,	0.69
	<hr/>
	99.85
	<hr/>

Percentage of ash, 2.125

3470. The quantity of nutritive matter derived from an acre of buckwheat, yielding a crop of 30 bushels, 1,300 lb., is of husk, 320 lb.; starch, sugar, &c. 650 lb.; gluten, &c. 100 lb.; oil or fat, 5 lb. (!) and saline matter, 21 lbs.†

3471. Buckwheat, which grows to a height of about 30 inches, is extensively cultivated over a great part of Northern Europe, as well as in Brittany, in Siberia, and on the table-lands of Central Asia. It is understood to be a native of Asia, and to have been imported into Europe in the fifteenth century. The seeds of the buckwheat are in some countries used as food, the mealy albumen being mixed with a portion of wheaten flour, of which a coarse bread is made. It is also used by the distillers at Danzig in the manufacture of cordials, but it is chiefly used as a green fodder.‡

3472. Buckwheat imported in 1847 was 22,917 quarters, in 1848 only 205 quarters; and

* Rham's *Dictionary of the Farm*—art. *Buckwheat*.

† Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 377, 893, 917, 928.

‡ Johnston's *Physical Atlas*—*Phytology*, Map, No. 2.

of buckwheat meal in 1847, 386 cwt., in 1848, 194 cwt. A duty of 1s. the quarter is payable on buckwheat, and 4½d. the cwt. on buckwheat meal.

ON THE SOWING, AND THE SUMMER CULTURE OF THE SUN-FLOWER.

3473. The sunflower consists of two species, the tall and the dwarf. The tall is what is best known in this country, though the dwarf is the favourite in France, as its leaves also afford an excellent food for cows. We shall confine our observations to the tall species.

3474. The tall sunflower requires a deep, mellow, rich soil, and also a large quantity of manure. Its long and strong stem renders it unfit to be grown in drills like turnips: the roots would not have a sufficient hold of firm soil to counterbalance the great leverage power of the tall stem. It should, however, be grown in rows, otherwise the ground would not be easily kept free of weeds. Its culture may be precisely that of the turnip up to the point of applying the manure, which should be ploughed in broadcast instead of in drills, and the quantity of farm-yard dung so ploughed in should not be less than 20 tons to the acre. Before the land is harrowed, 4 cwt. of guano to the acre should be sown upon the surface, and then the land should be harrowed both along and across the ridges, to make it fine. After this the small ribbing-plough, fig. 230, should make ribs along the ridges at 27 inches apart, into which the seed should be sown, by hand, along the ribs, at the rate of 7 or 8 lb. to the acre. As sunflower seeds are not heavy and easily disturbed in their place, it would be proper to cover them in the ribs with the hand-rake, instead of even the lightest harrows. The guano will cause the seed to germinate soon, and the dung below will support the plant, through its fibrous roots. When the plants have shot up sufficiently high to be distinguished, they should be thinned in the row to 12 inches apart; and, as the rows are on the flat, the thinning will better be done by hand, leaving the best plants, than with the hand-hoe, fig. 266. The root weeds may be eradicated with the scuffler, fig. 262, and the surface once afterwards with the drill-grubber, fig. 264, while

the ground between the plants, in the rows, is best cleaned with the hand-hoe. The crop may now remain until harvest.

3475. The sunflower belongs to the class and order *Syngenesia Frustranea* of Linnæus; the natural order *Compositæ* of Jussieu; and to *Epigynous Exogens*—alliance 50, *Asterales*—order 273, *Asteraceæ*—sub-order 1, *Tabulifloræ*—sub-division 4, *Senecionideæ*—tribe *Coreopsidææ*—genus *Helianthus*. A bland oil abounds in the seeds of many species of this extensive family of plants. Among the most remarkable is the common sunflower, whose large, sweet, nut-like seeds are very palatable and wholesome, and which yield 15 per cent of oil. The tall sunflower is *Helianthus annuus*, which, at one time, was a more common inmate of the flower garden than it is now. The dwarf species is *Helianthus indicus*. The specific characters of the sunflowers are leaves all cordate, rough, and three-nerved; flowers yellow; heads large and nodding; peduncles and stalks thick, the latter from 4 to 6 feet high; branched; annual. Native of South America; introduced in 1569.

ON THE SOWING, AND THE SUMMER CULTURE OF MADIA.

3476. Of this recently introduced plant Mr Lawson says that, "in its native country the madia has long been cultivated for its oleaginous seeds, the produce of which is deemed by many even superior to that of the olive and poppy. In Europe its culture was first attempted in 1835 by M. Bosch, royal gardener at Stuttgard, since which period it has been greatly extended, and that with the utmost success, under the patronage of his majesty the King of Würtemberg, and others. The following is extracted from a communication received along with a quantity of seed of the madia in 1839:—"From its valuable property of enduring winter and spring frosts, the madia may either be sown in autumn or spring, the ground being previously well pulverised. Four pounds of seed will suffice for sowing an acre in drills, and about six pounds for the same space broadcast. The young plants should be thinned out, so as to stand at least 4 or 5 inches apart. The crop should be reaped when the earliest seeds acquire a gray colour, and disposed in handfuls to facilitate drying, after which it should be immediately thrashed out, as, if stacked in the haulm, the viscid matter which adheres to the foliage would cause fermentation. The seeds should afterwards be washed in

warm water, to cleanse them of the same viscid or gelatinous and strong-smelling substance. The crop on an acre of poppies averages 12 bushels, which yields about 22 lb. of oil per bushel, or in all 264 lb. at 6d. = £6, 12; while an acre of madia produces on an average 26 bushels of seed, each of which yields about 17 lb. of oil, or in all 442 lb. at 6d. = £11, 1s. Chemical analysis shows that 100 parts of madia oil contain 45 of elain, (fluid fat,) 40 of stearin, (margarine, or solid fat,) and 15 of glycerine, a sweetish glutinous substance.”

3477. Professor Lindley observes, in regard to this remarkable plant, that it is “a Chilian plant, lately introduced with success into the agriculture of the drier parts of Europe. Madia oil expressed without heat is described as transparent, yellow, scentless, &c., and fit for salads; its cake is said to be good for cattle. It produces, in dry climates, as much oil per acre as poppy; in comparison with colza as 32 to 28; linseed as 32 to 21; and olives as 32 to 18.”*

3478. Mr Lawson further observes, that “a quantity of madia sown by us in the vicinity of Edinburgh, in May 1839, ripened seeds in August following; but the unusually rainy weather caused many of the plants to damp off after flowering. A portion of the seeds, which was sown immediately after harvesting, produced plants 2 or 3 inches in height that autumn, many of which perished in the course of the winter; but the remainder, although weak in spring, recovered sufficiently to produce a good crop of ripe seeds about the middle of July. Upon the whole,” Mr Lawson concludes, “there seems every probability that, in ordinarily favourable seasons, the madia sativa might be grown very successfully in Scotland.”† It would seem that the culture adapted to the turnip would in every respect suit this plant, and the richness of its seed could not fail to prove nourishing food to poultry and pigs.

3479. The madia is in the same botanical position as the sunflower, excepting in the natural system of Lindley, where it is in the tribe of

the *Sphenogynææ*. The madia, *Madia sativa*, the cultivated or oil-seeded madia, has these generic and specific characters:—Receptacle and seeds naked; involucre double, the outer usually 8-10 leaved, and much larger than the inner, which is composed of many leaves and scales. Plant upright, with numerous diverging branches, and, together with the leaves and involucre, covered with a very viscid glandulous hair or down; leaves lanceolate, entire, and more or less clasping; flowers inconspicuous, yellow, and much crowded at and near the extremity of the branches. Annual; 1½ to 2 feet high. Native of South America.

3480. According to Souchay, the seed of the madia sativa contains the following ingredients in its ash:—

Potash,	9.53
Soda,	11.24
Lime,	7.74
Magnesia,	15.42
Oxide of iron,	1.08
Phosphoric acid,	54.99
Sulphuric acid, . . . . .	...
Chlorine, . . . . .	...
Silica, . . . . .	...
	100.00‡

It will be observed how large a proportion of soda, magnesia, and particularly of phosphoric acid, the madia contains.

ON THE SOWING, AND THE SUMMER CULTURE OF MAIZE.

3481. Indian corn, as it is commonly called, but more properly maize, is unsuited to the climate of this country; but as many varieties of this plant exist, and as Schouw observes, in his account of the geographical distribution of the grasses, that of all the cultivated grasses “maize has the greatest range of temperature,” it is, perhaps, possible to select one variety that may succeed so far in our climate as to afford a means of supporting poultry, without having recourse to any of the species of grain cultivated for the use of man. It would appear that two varieties ripen their seeds in the course of our summer in ordinary seasons—one called by the French *Maïs-à-Poulet*, or chicken corn, brought from Egypt, which ripens its seed in 120 days from planting, but the crop derived from which is so scanty that it does not repay the trouble of cultivation; the other is called the *Forty Days' Maize*—

* Lindley's *Vegetable Kingdom*, p. 707.

† Lawson's *Agriculturist's Manual—Supplement*, p. 57-8.

‡ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 383.

not that it ripens its seeds in 40 days from planting, but because the male flower is ready to fecundate the crop in 40 days from planting, and the seeds come to maturity in 140 days after being sown, or in about 5 months. To this latter variety Mr Keene has, in 1849, directed the attention of the British farmers, remarking that the reason of the want of success attending the culture of the maize by the late Mr Cobbett was, because he cultivated an American variety, which are all known to be late of ripening in Europe; but it appears, by a letter in the *Gardeners' Chronicle* of the 31st of March 1849, from Mr James P. Cobbett, that the *Maïs Quarantain*, or *Forty Days' Maize* of the French, and "*Cobbett's corn*," are precisely the same plant. In fact, Mr Cobbett obtained his corn from Artois in France, and there was no want of success in his cultivation of it, but that at that time (1828) no interest was attached to its cultivation in this country. But now that substitutes must be found for the potato, in the success of the cultivation of which we can no longer place *implicit* reliance, for the feeding of the live stock, which was chiefly supported on the potato, the maize may now receive that attention to which it was not entitled under different circumstances. The question now is simply whether Cobbett's or any other variety of the maize may be raised in this country with a reasonable expectation of success; and it appears that it is worthy of a trial.

3482. The better the soil the better will the maize grow, but it will grow with proper culture in soils not of the finest quality, provided they be warm, sheltered from strong N.W. winds, exposed well to the sun, be free of bottom wet, and not of tough tenacious clay.

3483. As the maize does not occupy the ground very long, it may be cultivated in England on the land which has borne the winter tare or rape, which has been eaten down in spring with sheep, and the maize is removed in time in autumn for the sowing of wheat. In Scotland, there being no winter tares, it may succeed winter rape, where that is grown; but where not grown, the maize may occupy a part of the

fallow or green crop break, as a preparation of it for wheat in the autumn.

3484. The culture of maize is the same as that for the turnip, up to the dunging of the drills; and as we have already seen how greatly the crop of maize is increased in Peru by the application of guano, (3345,) it would be proper to sow 4 cwt. of guano over the 20 tons of farm-yard dung, given as the manuring, before covering the dung in the drill in the double mode, (2397.)

3485. The seed should be selected from the middle of the ear, as being there the best and strongest. It is no matter what colour it bears, whether dark purple, light red, yellow, or white, as it will not produce seed of the same colour, but only as many of the same colour in the same proportion. The seed should be steeped in water for 24 hours before being sown, and the quantity required is 6 pecks the acre. It has been recommended to steep the seed in the same sort of liquor as wheat is, for the prevention of smut, as the maize is liable to the ergot fully as much as the rye. Cobbett denies that the maize is affected by any disease or any insect, and perhaps the kind he cultivated may have experienced immunity from disease in this country; but no doubt exists that maize is affected with ergot, for, according to Roulin, it is very common in Colombia, and the use of it is attended with a shedding of the hair, and even the teeth, of both man and beast. Mules fed on it lose their hoofs, and fowls lay their eggs without the shell. Its action upon the uterus is as powerful as that of rye-ergot, or perhaps more so. The country name of the maize thus affected is *Maïs peladero*. This statement, however, as Professor Lindley remarks, requires confirmation.*

3486. The time for sowing maize seed is an important particular in the culture of the plant. The young plant is very susceptible of frost, and should the seed be sown as early as to have no assurance of freedom from frost, the plants may be so affected that, although they may not die, the leaves may become yellow, and the growth more backward than that of plants raised from seed much later sown. The frosts of

* Lindley's *Vegetable Kingdom*, p. 115.

April and the droughts from the east winds in May are dangerous periods, and ought to be avoided. Mr Keene gives an apparently infallible rule in the appearance of the cock-chaffer *Melolontha vulgaris* in the air, as indicative of the temperature in which maize may be sown in safety, and this period usually occurs from the middle to the end of May. No apprehension need be entertained of the crop being too late, for the flowering of the plant will then take place in the finest part of the season, in July, and even early frosts in autumn will not injure the fruit within its covering.

3487. In sowing the seed, Mr Keene recommends the dropping it in the drills between the finger and thumb at distances of 3 inches, and then to cover it in ploughing the drill.* But such a procedure would be too rough treatment of the seed of a plant that requires the tenderest care we can bestow. A better plan is to cover the dung in the drill before sowing the seed; and as the seed should not be buried beyond 2 inches in depth, the top of the drills should be rolled with the concave roller of the turnip sowing-machine, fig. 254, without the coulters, a rut of about 2 inches deep made along the top of the drills with the corner of the hand-hoe, fig. 266, and the seed then either dropped by hand into the rut, or with the bean-drill barrow, fig. 219, at 3 inches or thereabouts apart, covered over with the earth cast up by the rutting with the hoe, and the drills again rolled with the concave rollers, which will finish the work in fine style.

3488. The spikes of the young plant may be expected to break the ground in about 6 or 8 days. As the ground at this season is easily overrun with weeds, the scuffler, fig. 262, will have to eradicate them in the space between the drills, and pare away the soil from the sides of the drills in preparing for the singling. When the plants have attained 3 or 4 inches in height, they are singled to a distance of 9 inches apart with the hand-hoe, fig. 266. Cobbett, in his own humorous style, thus alludes to the weeding: "Let us now suppose the corn plants to be 3 inches high. Long before this *weeds* will begin to ap-

pear, for they were in the ground long before the corn, and they claim their right of primogeniture, and act upon that right. They will not rise to the same height with the corn plants; but their inferiority in point of height will be made up for in numbers, and the poor corn plant, if left to itself, will soon be a Gulliver, when bound down by the Lilliputians."† It is recommended by Mr Keene to protract the ultimate thinning for some time, that the plants so taken out may be used as green food. But this is not the object of the culture, which is to produce a crop of seed; and to do so in the best manner, the ground should be allowed to exert its fullest powers for that purpose, by the removal of all superfluous vegetation, whether of weeds or of superfluous plants. For the same reason, no roots or haricot beans ought to be sown in the drills of maize. All catch crops are no better than robbers of the plants among which they are sown.

3489. After another drill-grubbing, fig. 264, and hoeing, to remove the surface weeds, the maize plants will grow with great rapidity, perhaps an inch a-day, until the flower spike appears; and so far from other plants being allowed to compete with the principal crop, the suckers which spring from the roots of the standing plants should be removed, and on removing them both hands should be employed—one in stripping down one sucker, and the other another sucker, in the opposite side, at the same time. The suckers may be used as green food by the pigs; they should not be given to cows, as green maize invariably causes a decrease of milk in them, though it enriches the butter. "The maize now lances out its flower from the seed sheath," says Mr Keene; "then the seed cob forms, and sends forth its pretty drooping yellow, red, or bronze-coloured silken feather, falling down gracefully upon the smiling head of corn. The flower-stalk shoots up rapidly; its growth is marvellous, and the broad dark green flag-leaves of the healthy crop denote the strength of the vegetative power which is rapidly pouring into the whole system of this splendid plant. As this begins to retreat, the graceful feather shows signs of withering; the sap no longer circulates

* Keene's *Facts for Farmers—Maize*, p. 6.

† Quoted by Amicus Curie in *Maize against Potato*, p. 130.

with the same vigour; it is time to confine the remaining strength to the cob, and the flowering-stalk is cut off by a draw of the knife, at an inch higher than the first joint above the cob. Women do this, walking along the rows; and when they have thus gathered a handful of 12 or 15 flower-heads, they bind them round with a leaf, and hitch the little bundle, stalk-end upwards, on the stick of the standing stem, where it hangs for 4 or 5 days to dry, becoming excellent winter food for cattle." The criterion for removing the flower-heads is when all the farina has completely quitted the tassel, and the tassel is dead and dry; also a perfect deadness of the end of the silk of the cob, where, instead of the bright green that appeared before, gracefully hanging down, a little bunch of withered-up and brown-looking stuff is seen. The farmer should choose his time for topping, when the weather is wet and unfavourable for other work; neither need it be all done at one time, unless the plants are in a fit state for the operation. Mr Keene's Forty Days' Maize only bears one cob, which contains about 48 seeds.

3490. In the case of localities in which frost is felt until late in the season, it is possible to raise plants of maize in a piece of good ground sheltered from frost; and when they have attained a height of 8 or 9 inches, to transplant them in the prepared drills at 9 inches asunder, and in case some of the plants die, to reserve a few to fill up the gaps. The transplantation may be deferred until the third week of June, when all dread of frost is at an end.

3491. In finishing the summer culture of the maize, the drills are set up to their original form with the double mould-board plough, fig. 214; and this operation should be completed before the plants have attained such a size as to come in contact with the horse or implement. The flowering season is so critical to the maize, that no operation should be permitted that would in the least agitate the plants; and for this reason windy weather is unfavourable for the crop at that stage of its growth. The crop, after being set up, remains until

the harvest. The plants are never laid with rain or broken down by the wind, though the latter may cause some of them to lean over a little.

3492. Maize is of the class and order *Triandria Dignia* of Linnæus; of the natural order *Gramineæ* of Jussieu; and of *Endogæ*—alliance 7, *Glumales*—order 29, *Graminaceæ*—tribe 2, *Phalaraceæ*—genus *Zea*. The maize, *Zea mays*, has male and female organs in distinct flowers, but on the same plant: male in branching terminal spikes; female in a concealed spike or elongated receptacle, proceeding from the joints of the culm or stalks; calyx a two-valved blunt glume; corolla a two-valved glume; style one, long and pendulous, protruding considerably beyond the leafy envelope of the seed spike; seeds solitary, immured in an oblong common receptacle.

3493. Maize is also called Turkish wheat. "The origin of this plant has been disputed. In the equatorial countries of America, maize is cultivated, according to Humboldt, at an elevation of 7,600 feet. In Europe, when cultivated in the open fields and for its grain, not as green fodder, its northern limits extend to latitude 47°. It is cultivated in abundance between La Maas and La Fleche, (lat. 48°) for feeding fowls. From this the limit is traced with some difficulty, around Paris to Frankfort on the Maine, (lat. 50° 30'.) Farther east its limits are not ascertained. In the plain of Brandenburg (lat. 52° 30') it yields abundantly, but is little cultivated, and that only for fodder. In Eastern Europe it occurs on the banks of the Dneister, (lat. 49°;) beyond this its limits are unknown. Maize is an annual plant, which only requires heat in summer, and is not influenced by the cold of winter. In North America, maize is cultivated more extensively than in Europe; in the interior of Canada, its northern limits reach the parallel of lat. 50°. The highest point at which it has been cultivated in Europe is the village of Lescans, in the department of Basses Pyrenees, situated 3,280 feet above the level of the sea. This is above the limits of the vine, which only reaches 2,620 feet."* According to Schouw, in respect of the predominating kinds of grain, the earth may be divided into five grand divisions or kingdoms. The kingdom of rice, of maize, of wheat, of rye, and lastly of barley and oats. Rice, maize, and wheat, are the most extensive, and the rice supports the greatest number of the human race. The maize has the greatest range of temperature.†

3494. I have already given the composition of maize in (1303,) and of the composition of the ash of the grain of the maize in (1304.) Every bushel of maize leaves about a pound of ash. I shall now give the composition of the ash of maize straw, grown near Gratz by Hruschauer:—

* Johnston's *Physical Atlas—Phytology*, Map No. 2.

† *Edinburgh New Philosophical Journal* for April 1825.

Potash,	14.46	4.78
Soda,	39.92	12.69
Lime,	4.93	11.00
Magnesia,	1.84	11.44
Oxide of iron,	0.90	0.73
Phosphoric acid,	11.76	22.39
Sulphate of lime,	1.01	1.37
Chloride of sodium,	6.29	0.55
Silica,	18.89	35.05
	<hr/>	<hr/>
	100.00	100.00
	<hr/>	<hr/>
Percentage of ash,	2.30	6.50

Professor Johnston makes these important general remarks, in regard to the great discrepancy between the results in these two analyses. "Between these results we observe great differences, both in the total percentage of ash left, and in the proportions of every one of the constituents which the ash contains. This is by no means unexpected, but it illustrates a fact, that our knowledge of the inorganic constituents of plants—of the function performed by them in the several parts of plants—and of the proportions required most perfectly to perform these several functions—is yet in its infancy."*

3495. The importation of maize in 1847, the year of the Irish famine, was as great as 3,608,312 quarters, and in 1848, 1,586,771 quarters. Of maize meal in 1847, 1,448,837 cwt., and in 1848, 234,114 cwt. were imported. A duty of 1s. a quarter is payable on maize, and of 4½d. the cwt. on maize meal.

THE RATIONALE OF THE GERMINATION OF SEEDS.

3496. Now that we have proceeded through the whole course of the seed-time, incidental to spring and to the early part of summer, and the finishing of which terminates for a time one busy period of farm operations, it will prove useful to rest a while from actual labour, and consider the principles upon which the success of the operations we have been conducting, chiefly depends. By obtaining a clear view of the circumstances which best promote the germination of the seeds of the crops we have been sowing, and of the earliest growth of the plants arising from them, we shall be enabled to conclude whether or not the practice we pursue, in sowing seeds, is calculated to afford those circumstances which best promote their germination and the growth of the plants from them.

3497. The healthy seed of a plant is a

living object. Though apparently lifeless to the sight and the touch, it has life, and its vitality is capable of exerting great power when excited into action. What the agent is, and how it acts, which excites the vitality of seeds, we do not know, and perhaps never shall know—it may be one of the secrets which nature will keep to herself; but we do know the circumstances in which, when seeds are placed, vitality is invariably excited, and the proof of this excitement is furnished by their germination, which is the first movement towards the production of a plant.

3498. Now the circumstances which excite germination, are a combination of air, heat, and moisture. These must be afforded in the most favourable conditions, before the plant will grow. They may all be supplied to the seed, and its germination secured in the air as certainly as in the ground; but on the development of the radicle, the province of which it is to penetrate into the soil, the young germ, instead of growing upwards, would die, were it kept constantly in the air. The earth supplies all the requisites of air, heat, and moisture to the plant, in a much better state than the air can of itself, and the soil continues to supply them, not only at the period of its germination, but during its after life. A vital seed placed in the ground must be affected by three agencies, one physical, another chemical, and a third physiological, before it can produce a plant.

3499. *Physical.*—When a vital seed is placed in pulverised ground it is surrounded with air; for although the particles of soil may seem to the eye to be close together, on examination it is found that the interstices between the particles occupy one-fourth of a given quantity of soil. Hence, 100 cubic inches of pulverised soil contain no less than 25 cubic inches of air. Therefore, in a field, the soil of which has been ploughed and pulverised to the depth of 8 inches, every acre of it will contain 12,545,280 cubic inches of air; and hence also, as every additional inch of depth pulverised, calls into activity 259 tons 5 cwt. 32 lb. of

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 375.

soil, at 1.48 of specific gravity, (119,) so the ploughing of the soil deeper every inch introduces into it an additional 1,568,160 cubic inches of air. Thus, by increasing the depth of pulverised soil, we can provide a depot of air to any extent for the use of seeds. Suppose that as much as 3 bushels of wheat are sown on the acre, 2,104,704 seeds will be sown, (1856,) so that each grain will have about 6 cubic inches of air in a soil 8 inches deep.

3500. But this air must be above a certain temperature ere the seed will germinate—it must be above the freezing point, else the vitality of the seed will remain dormant. A pulverised state of the soil affords great protection to the seed from a considerable depression of temperature, and the more finely it is pulverised, the more it will resist the induction of cold from without, and the less will it radiate the heat from within. The less finely the soil is pulverised, such as in fig. 277,

Fig. 277.



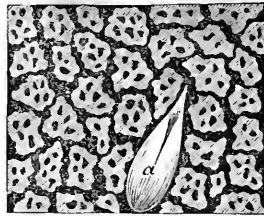
CLODDY AND STONY SOIL.

where a seed *a* is placed among hard clods *b*, on the one side, and near a stone *c* on the other; with a few particles of fine earth hard by, neither the clods nor the stone can afford the seed any air, which can only be supplied through the few particles of pulverised soil; but cold is easily transmitted by stone from the atmosphere, with which it communicates by its upper surface, and by which also the internal heat is easily radiated into the air. It is clear then, that, in such circumstances, seed is not placed in favourable circumstances for its germination. The advantages of pulverised soil are evident from this figure.

3501. Besides by clods and stones, the air may be excluded by water. Fig. 278 represents the seed *a* placed in a pulverised soil, the interstices of which are entirely occupied by water, instead of air, as well as the interior of all the pulverised particles of it. It is also clear that, in this case too, the seed, being deprived of air, is not placed in the most favour-

able circumstances for germination. Besides the direct exclusion of the air, the water, on evaporation, renders the earth around each seed much colder than it would otherwise be. The evils of the excess of moisture are evident from this figure.

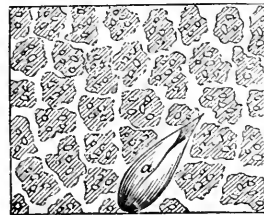
Fig. 278.



SOIL WITH WATER AND WITHOUT AIR.

3502. But total want of moisture prevents germination as much as excess. Fig. 279 shows the seed *a* placed in pulverised soil, and the interstices filled with air, but no moisture is visible between and in the particles of soil. In such a state of soil, heat will find an easy access to the seed, and as easy an escape from it. The evils of the want of moisture, and of excess of heat, are evident from this figure.

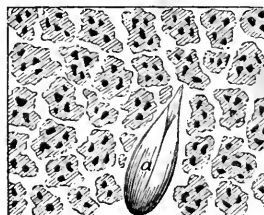
Fig. 279.



SOIL WITH AIR AND WITHOUT WATER.

3503. Fig. 280 represents the seed *a* in soil completely pulverised; between every particle of the soil the air finds easy access to the seed; and in the heart of every particle of soil moisture is lodged. All that is here required in addition is a favourable temperature, which the season supplies, and germination proceeds.

Fig. 280.



SOIL WITH WATER AND AIR.

3504. *Chemical.*—The chemical composition of seeds consists of organic and inorganic substances. The organic are

composed of two classes of elements, the azotised and the non-azotised: the inorganic of earthy, alkaline, and acid ingredients. The azotised elements consist of matter analogous to the casein of milk, albumen of the egg and of blood, and of the fibrine of the flesh of animals; the non-azotised consist of starch and mucilage, and of fatty and oily matters rich in carbon and hydrogen. The proportions of the starch, and of the mucilage, do not vary much in most seeds; but in other respects the composition varies considerably—in some the gluten predominating, in others the oil, and by which the distinctive qualities of the plants are characterised.*

3505. A seed, when fully ripe, contains a large proportion of carbon or mucilage, and, as long as it continues to be charged with either, it is unable to grow. It is only able to grow when placed in circumstances in which it can get quit of a large proportion of the carbon or mucilage, and this it is enabled to do when sown in the ground.

3506. When a seed is consigned to the ground, the first change which takes place in it is physical—it becomes increased in bulk by the absorption of moisture. If the moisture is presented to it in the proportion represented in fig. 280, it is placed in the most favourable circumstances for germination; it then receives moisture and air, and only requires the requisite degree of temperature to excite its vitality into action. If it is placed in want of moisture, as in fig. 279, it will remain in a state of dormancy until moisture arrive, and in the mean time may become the prey of the many animals which inhabit the soil, eager for food, or be scorched to death by heat. If it is placed in excess of moisture, as in fig. 278, its germination is prevented by the exclusion of the air, and its tissues are destroyed by maceration in the water. In favourable circumstances, besides the direct effect of the absorption of moisture in increasing the bulk of the seed, it softens and expands all its parts; many of the dry and soluble parts become fluid; sap or vegetable food is formed, and a sort of circulation established, which communicates between the more remote parts of the embryo.

3507. Heat, if now present, assists the elements of air and moisture to excite the vital principle into action. It expands the air contained in the numerous cavities of the seed, produces distension of all the organic parts; and, their irritability being thus excited, the seed cannot be destroyed but with death.

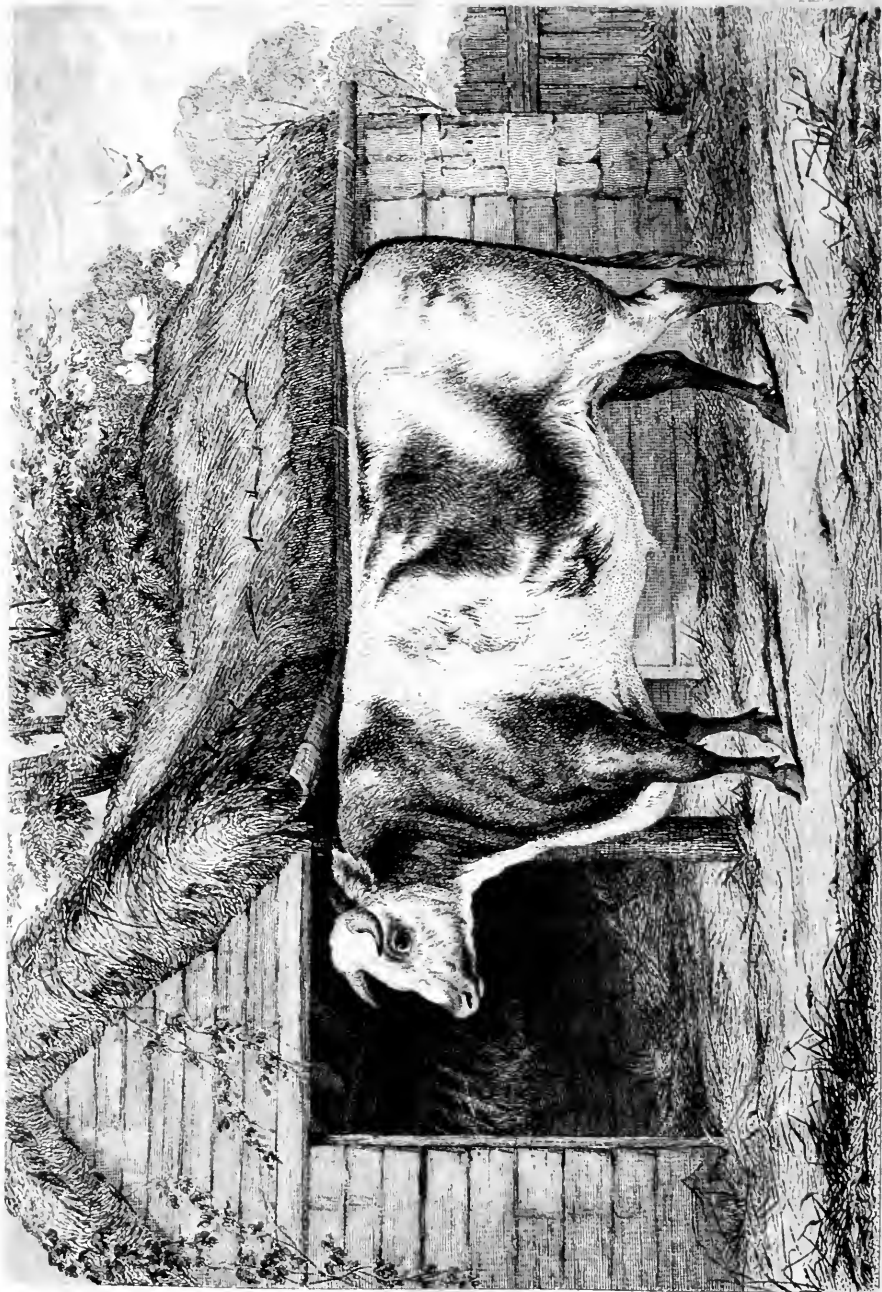
3508. Immediately on the enlargement of bulk by the moisture, and the excitation to vitality by heat, a chemical change takes place in the constitution of the seed. The vital principle decomposes the water absorbed, fixes its hydrogen for future purposes, and its oxygen, uniting with the carbon of the seed, forms carbonic acid, which is parted with by the respiratory organs into the air, and of the seed into the soil, most of the ingredients of the latter absorb it. The carbon is thus got rid of until the proportion is reduced to the amount best suited to its being appropriated by the embryo plant. The evolution of the carbonic acid may be one source of the heat which becomes manifest during germination, just as Liebig has pointed out the source of animal heat by a similar cause in the animal economy. It thus appears that oxygen is essential to germination, since no seed will germinate in hydrogen, nitrogen, or carbonic acid.

3509. When the seed begins to germinate a substance named diastase is formed at the expense of its albumen. The functions of diastase are important, being to convert the insoluble starch of the seed into soluble dextrin and sugar; to effect which change it seems to possess extraordinary power, as one part of diastase will convert into sugar no less than 2000 parts of starch. The diastase is formed at the base of the germ; and as the seed shows the first signs of germination there, the diastase converts the starch which it finds there into a useful state for the support of the first efforts of vegetation, and, after having performed this important function, it disappears.

3510. Acetic acid is formed in the chemical changes effected by germination, but whether it or diastase is first formed, after germination commences, is uncertain.

* Boussingault's *Rural Economy*—Law's translation, p. 19.





The action of dilute acids gradually changes starch into dextrin, then into cane sugar, and lastly into grape sugar. After the acetic acid has been ejected by the plant, it may serve to dissolve lime, and other earthy matters contained in the soil, and Liebig conjectures this to be an especial function of this acid.

3511. "Under fitting circumstances," says Professor Lindley, "the embryo which the seed contains swells, and bursts through its integuments; it then lengthens, first in a direction downwards, next in an upward direction, thus forming a centre or axis round which other parts are ultimately formed. No known power can overcome this tendency, on the part of the embryo, to elevate one portion in the air, and to bury the other in the earth; but it is an inherent property with which nature has endowed seeds, in order to insure the young parts, when first called into life, each finding itself in the situation most suitable to its existence—that is to say, the root in the earth, the stem in the air."

3512. When the germ has shot out from the seed, and attained to a sensible length, it is found to be possessed of a sweet taste, which is owing to the presence of grape sugar in the sap which has already begun to circulate through its vessels. There is little doubt that the grape sugar is formed subsequently to the appearance of both diastase and acetic acid.* "With the assistance of this saccharine secretion," continues Professor Lindley, "the root, technically called the radicle, at first a mere point, or rather rounded cone, extends and pierces the earth in search of food; the young stem rises and unfolds its cotyledons, or rudimentary leaves, which, if they are exposed to light, decompose carbonic acid, fix the carbon, become green, and form the matter by which all the pre-existing parts are solidified. And thus a plant is born into the world; its first act having been to deprive itself of a principle (carbon) which, in superabundance, prevents its growth; but, in some other proportion, is essential to its existence."†

3513. It is easy to comprehend why light is prejudicial to germination. In

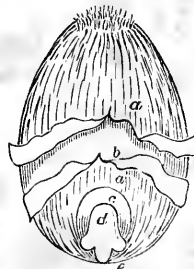
light the leaves of plants absorb carbonic acid and give off oxygen, and seeds exposed to light follow the same law; but in the process of healthy germination, carbonic acid is given off and oxygen absorbed. Hence to attempt to germinate seeds in the light is to reverse the order of nature; and the best way to exclude the light is to cover the seeds with earth.

3514. In oily seeds having no starch mucilage takes its place, which, being easily dissolved, transfuses itself into the circulation, and is converted into dextrin or cellulose, as the case may require.

3515. Turnip and carrot seed have no starch, but they contain pectic acid, which being changed into dextrin, leaves carbon and oxygen to be used as the occasion may require.

3516. *Physiological*.—A seed considered in reference to its organisation consists of an embryo, which includes the germs of the root and of the stem, and of a cotyledon or cotyledons.

3517. Fig. 281 represents a grain of wheat magnified, and so dissected as to show its component parts. It consists of two skins, an outer and an inner—*a a* the outer, and *b* the inner skin: *b* is also where the nutritive matters, called the starch and albumen, are situate, and these constitute the whole seed; *c* is the little scale or coty-



LEDON THROUGH WHICH the nutritive matter passes in the sweet state, when the grain is germinating, and by which it is rendered most fit for the nourishment of the little plant; *d* is the rudimentary plant, at the base of which 3 tubers may be seen, from which as many roots or stems, or both, will afterwards proceed; and *e* is the point where the nutritive matter, the little scale, and the rudimentary plant, are united. All these parts are essential to the growth of the seed, since, any one being absent

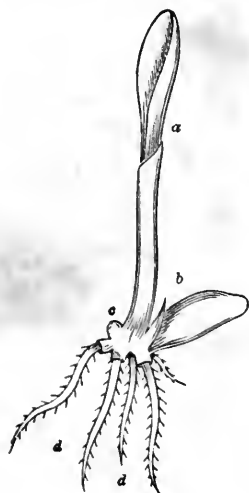
* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 221-8.

† Lindley's *Theory of Horticulture*, p. 8-10.

by accident or design, the seed fails to spring.

3518. The seeds of most species of plants possess such a structure as that only one stem can proceed from them; but in the grasses, and particularly in the cereal ones, which yield human food, a remarkable departure from this structure is observed. In them the embryo plant is usually thickened towards its base, and is so organised that, instead of one stem, 3 or 4 usually spring from one grain; and, in some cases, the number of stems is so great

Fig. 282.



A PLANT OF WHEAT IN THE STATE OF GERMINATION.

3519. Fig. 282 represents such a grain in a state of germination, one shoot *a* having left the sheath, another *b* is just evolved, and a third *c* remains unevolved; and *d d* are the rootlets. It is this peculiarity of structure which compensates, in some degree, for the great loss sustained from the destruction of seed, on sowing the cereal crops.

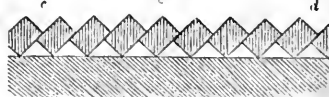
3520. The force of the vegetation of a single seed is as great as to raise a weight of 200 lb., as has been proved by its splitting hollow balls, in the manner the Florentine academicians measured the expansive force of freezing water, (644.) In 1847 a small fungus upheaved from its bed a large flag-stone in a foot pavement in one of the squares of Edinburgh.

ON SOWING, BROADCAST, DRILLED, AND DIBBLED—THICK AND THIN—AND AT DIFFERENT DEPTHS.

3521. *Broadcast sowing.*—Of all the modes of sowing the seeds of the cereal crops, none requires so much seed as the broadcast. The usual quantity of seed sown is 3 bushels of wheat, 4 bushels of barley, and 6 bushels of oats to the acre. Thirty years ago the quantities of seed sown were larger, viz. :—4 bushels of wheat, 6 of barley, and $7\frac{1}{2}$ of oats. These quantities I myself have sown.

3522. However well the land may be ploughed, the seed sown broadcast will braird irregularly—some falling into the hollowest part of the surface, some upon the highest, and some being scarcely covered with earth by the harrows—some sliding gently into the rut after the tines have passed, whilst others are carried as deep into the ruts as the tines themselves penetrate. To harrow the land smooth, previous to the sowing of the seed, would not cure the inconvenience of irregular covering, since it is impossible to cover so large a seed as that of the cereals, merely with the action of the tines of the harrows, without the assistance of a rough surface of mould. On smooth harrowed ground the seed would be left on the surface, and even harrowing, as presently conducted, leaves many seeds exposed, to be picked up by granivorous birds. What I have stated may be illustrated by the following figures, where from *c* to *d*, fig. 283, are represented furrows, well and re-

Fig. 283.



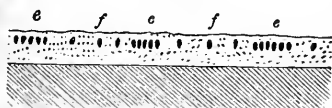
WELL-PLOUGHED REGULAR FURROW-SLICES.

gularly ploughed; but it is obvious that although the seeds will fall successively more into the hollows between the furrows than upon the sharp points, when scattered broadcast from the hand, yet some will fall on the points and sides of the furrows. The seeds will lie in the ground, as shown in fig. 284, where those are thicker at *e*, which fell into the hollows of the furrows, and thinner at *f*, which stuck upon their apex, or on their sides. But even their

position will not be so regular as is here represented, where all the seeds are at the same depth from the surface, for some will

is shown in fig. 287, where some seeds are clustered together and covered in a shallow

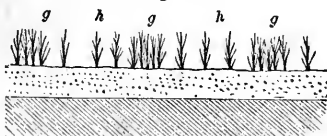
Fig. 284.



THE POSITION OF SEEDS WHEN SOWN ON REGULAR FURROW-SLICES.

be deeper than others, some too deep, and others too shallow, whilst not a few will have been left exposed on the surface. From such a deposition, as in fig. 284, the plants will come up in the irregular manner represented in fig. 285, where *g* are clumps

Fig. 285.

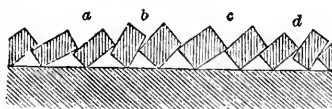


IRREGULAR BRAIRDING FROM EVEN REGULAR FURROW-SLICES.

of too many plants, and *h* straggling ones too far asunder. But in reality, the seeds having been deposited at different depths, the plants will present greater irregularity of height than is shown in fig. 285.

3523. But when the land is ill ploughed, the case is still worse. Fig. 286 shows the

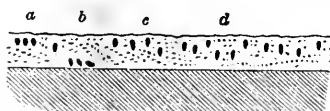
Fig. 286.



ILL-PLOUGHED IRREGULAR FURROW-SLICES.

irregular manner in which the furrows are placed by bad ploughing. Bad ploughing is attended with bad consequences at all seasons, in forming the seed-furrow for any kind of crop, but particularly for a cereal one, inasmuch as irregularity of surface cannot be amended in this by the cleansing implements in future operations, as might be the case in a green crop. Seed sown on the irregular surface of fig. 286, where *a* is a narrow deep furrow, *b* a shallow one, *c* a large one of ordinary depth, and *d* one having a high and steep side, will be covered in an irregular manner, as

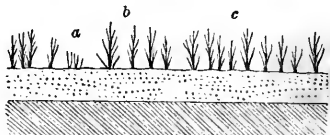
Fig. 287.



IRREGULAR DEPOSITION OF SEED ON ILL-PLOUGHED FURROW-SLICES.

manner at *a*; others also clustered, but buried deep, at *b*; whilst many are scattered irregularly at different depths, at *c* and *d*. It is obvious, from such a deposition of the seed, that the braird must come up in a very irregular manner, likely to affect the future progress of the crop; for we have only to look at such a braird to be convinced that the plants have not all the same chance of arriving at maturity at the same time; and, if a crop does not mature alike, the grain cannot be alike in the sample. In fig. 288, where the seed was

Fig. 288.

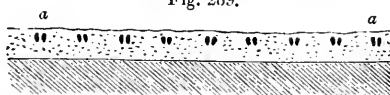


IRREGULAR BRAIRD ON ILL-PLOUGHED FURROW SLICES.

sown very deep, it will produce plants that will come up late, as at *a*; while that covered in a shallow manner will send up plants early, as at *b*, which will push on in growth when the weather is favourable, and get far in advance of the late ones at *a*. The remainder at *c*, coming up in a more regular manner, will form the best part of the crop.

3524. *Drill-sowing*.—One evident advantage of sowing with a drill over a broadcast machine, is the regular deposition of the seed at one depth, whatever depth may be chosen. Fig. 289 represents the seeds deposited at regular intervals, from *a* to *a*. The figure is supposed to be a cross section of the ground, as also of the

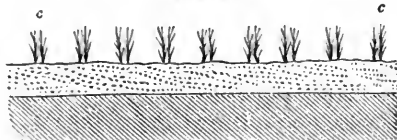
Fig. 289.



REGULAR DEPTHS OF SEED BY DRILL-SOWING.

seeds in the lines of rows as sown with the drill. The braird is shown also in cross section from the drilled seed in fig. 290 from *c* to *c*, where the plants seem all

Fig. 290.



REGULAR BRAIRD FROM DRILL-SOWN SEED.

of the same height and strength, and their produce may reasonably be expected to be of the same quality. What makes drilled seed be certainly retained at a uniform depth is the harrowing of the land into a smooth state before the drill sows the seed.

3525. Certain as the result of the drill-machine is in depositing the seed at a stated depth, there are objections to sowing corn in rows, which all drill-machines do, that are not applicable to broadcast sowing; and could the seed be deposited at a uniform depth in broadcast, the objections would be disposed of. One objection to all grain crops placed in rows is, that the air, having free access along the rows, encourages the growth of weeds; to destroy which, certain implements, named horse and hand hoes, are used to stir the ground. And, as in their progressive growth the plants throw out innumerable root-fibres in every direction, in search of food, those which occupy the open space between the rows are destroyed in common with the weeds; and although no estimate can be formed of the amount of injury which plants sustain in such destruction of their root-fibres, it is consonant to reason that those fibres must be essential to the welfare of the plants, otherwise they would not be sent forth by them. It would therefore be worth while to ascertain by experiment the comparative results derived from depositing seed broadcast at a uniform depth with the same quantity of seed drilled in rows at a like depth. The drill-sowing machines commonly in use are described under figs. 205 and 206.

3526. *Dibble-sowing.*—Dibbling, or dibble sowing, is the distributing of seed by means of a dibble at given distances, at a uniform depth in the soil, and the distribu-

tion may either be in rows or broadcast, though commonly it is in rows. The difference betwixt dibbling and drilling is, that the latter places the seed in continuous lines, while the former places it in rows, at intervening distances in the row. The object of dibbling is to fill the ground with plants with the least quantity of seed. The seed when sown in rows with the dibble appears as those in fig. 289, viewed along one row, and the plants from them come up as shown in fig. 290, standing at intervals when also viewed along a row. The depth of the seed and the equal brairding of the plants are as uniform as in the case of drilling, while the plants in each dibble hole stand independent of the rest.

3527. *The waste in seed.*—When sown in all these ways in equal quantities, this is surprising, as may be determined both by reason and experiment. Wheat at 63 lb. the bushel gives 87 of its seeds to the drachm, or 701,568 to the bushel, (1856,) in apothecary's weight, or 865,170 in avoirdupois weight. Now, 3 bushels of seed are sown on the acre, or 2,595,510 grains of wheat. Suppose that each grain produces one stem, and every stem bears an ear containing the common number of 32 grains, the produce of the acre should be 96 bushels; but the heaviest crop in Scotland seldom exceeds 64 bushels the acre, so that 32 bushels to the acre, or 33 per cent of the seed, is lost in the best crops, and 58 per cent in an ordinary one of 40 bushels.

3528. The waste in barley seed may be estimated thus:—Chevalier barley at 57 lb. the bushel, and 75 grains to the drachm, gives 547,200 grains to the bushel, apothecary's weight, (1911,) or 665,242 avoirdupois weight. Four bushels of seed are sown to the acre, which gives 2,660,968 grains to the acre; and taking one stem from each grain, and the produce of an ear at 32 grains, the produce should be 128 bushels; but the best crop in Scotland does not exceed 60 bushels, which gives a loss of 53 per cent on the best, and of 62½ on an ordinary one of 48 bushels.

3529. In like manner the loss upon oats may be estimated. The potato oat of 47 lb. the bushel, and 134 grains to the

drachm, gives 806,144 grains to the bushel, apothecary's weight, (1930,) or 978,968 avoirdupois weight. Six bushels of oats are sown to the acre, which gives 5,879,808 grains to the acre; and taking one stem from each grain, and the number of grains in an ear at 44, the produce should be 264 bushels; but the largest crop in Scotland I know of, is 114 bushels to the acre, and a poor one is 36 bushels. The loss of seed on the best crop is more than one-half, and on the poor one six-sevenths.

3530. Another view of the thickness of seed as sown is this:—2,595,510 grains of wheat the acre give 536 grains to the square yard; 2,660,968 grains of barley give 550 grains to the square yard; and 5,879,808 grains of oats give 1214 grains to the square yard. In the cases of wheat and barley, the proportion of seed is in proportion to their respective weights, but in the case of oats the seed is more than double in proportion to the weights of the grains, probably because the weight of oats is made up by that of its thick husk.

3531. Mr M'Lagan, junior of Pumphreston, Mid-Lothian, made experiments at my request in the spring of 1849, for the purpose of ascertaining the waste of seed in sowing oats in the three different ways of dibbling, drilling, and broadcast. The oats weighed 42 lb. the bushel. The dibbled holes were made 6 inches apart, and 6 inches between the rows, making 36 holes in the square yard, and each hole was supplied with from one to four seeds, making the quantity sown from one peck to four pecks the acre; and the seeds sown drilled and broadcast were in the same proportion. In drilling and dibbling, the seed was inserted 3½ inches into the ground. The results were these:—

	Dibbled.	Drilled.	Broadcast.
From 36 grains sown, 26 plants, 32 plants, 19 plants came up.			
.. 72 49 .. 53 .. 52			
.. 108 75 .. 78 .. 68			
.. 144 120 .. 94 .. 87			
300	270	257	226
Percentage,	.750	.714	.628

There is not much difference in the brairding of the seed sown dibbled and drilled, excepting the case where four seeds were sown; and this might have been expected, since the seeds in both ways were deposited much in the same circumstances in the

soil; but the broadcast method involves a loss of seed beyond the others of 16⅔ per cent—an anticipated result, since many of the seeds were necessarily left unbred on the surface, and some perhaps buried too deep by the harrow tines. The seeds were all sown on the same day, the 19th March, and the thickest sown of the drilled and broadcast brairded first on the 16th April. For three nights after that, severe frosts occurred, which may have had a more injurious effect on the shallowest covered seed of the broadcast than on the other kinds of sowing. Every one of the brairds seemed quite thick enough for a crop.

3532. Mr M'Lagan extended the experiment by sowing 7 pecks of oats drilled, or 252 grains to the square yard, and from these 208 plants came up, giving a percentage of .825. He also sowed 24 pecks to the acre broadcast, or 864 grains to the square yard, of which 570 produced plants, giving a percentage of .671, only a little more than in the former case of broadcast. Thus, 7 pecks of oat seed gave the largest return of plants brairded. Still the ultimate yield from the respective quantities of seed sown has yet to be ascertained.

3533. Mr Hay of Whiterigg, in Roxburghshire, also performed similar experiments for me at the same time, by dibbling and drilling wheat, barley, and oats, and by sowing oats in broadcast. The *dibbled* seeds were put into holes within 3 inches square to the number of 1, 3, and 6 grains in each hole, which gave respectively 144, 432, and 864 grains to the square yard. The seeds were sown on the 16th March 1849, and the plants counted on the 8th May. The results were these:—

	After 144 seeds.	After 432 seeds.	After 864 seeds.	
Of Wheat sown,	97	296	616	1009 plants came up.
Barley, . . .	95	335	687	1117
Illopetoun } oats, . . .	129	403	800	1332
Potato oats,	135	407	823	1365
Birley do.	125	413	777	1315
Sherriff do.	132	405	751	1288
Percentage of Wheat came up, }	.67	.69	.71	average .69
Barley, }	.66	.79	.79	.75
Oats, }	.90	.94	.91	.92

3534. On the 25th March similar seeds were sown in *drills* at the same rates per square yard, and the plants counted on

the 8th May, when the results were the following:—

	After 144 seeds.	After 432 seeds.	After 864 seeds.	
Of Wheat sown,	105	327	652	1084 plants came up.
Barley,	86	318	747	1151
Hopetoun oats,	139	408	798	1345
Potato oats,	137	407	795	1339

Percentage of Wheat came up, }				
	.73	.75	.75 average	.74
Barley,	.60	.73	.86	.73
Oats,	.96	.94	.92	.94

On comparing the braids of the drilled with the dibbled seeds, the barley and oats do not exhibit much difference, but the wheat incurs less loss of seed when drilled than when dibbled, in the ratio of 1009 to 1084. On comparing the results obtained by Mr Hay in the cases of dibbling and drilling oats with those by Mr M'Lagan, Mr Hay obtained a braid of nine-tenths of the seed sown in both cases; while Mr M'Lagan only obtained seven-tenths; and, in the case of sowing oats broadcast, he obtained a still smaller braid, namely, six-tenths.

3535. After a lapse of ten days, on the 18th May, when rain had fallen in the interval, the plants sown broadcast were counted, and they were unexpectedly found in greater number than the seeds sown. The plants therefore must have tillered in the course of the ten days during the rain, and the tillering was ascertained to be to the following extent:—

Seeds.	Plants.	Tillering
315 Barley produced	360	= one-sixth.
325	405	= one-fourth.
471 Sherriff oats	930	= double.
520	648	= one-fifth.
666 Potato do.	704	= one-sixteenth.

On account of the wet weather in the course of the ten days, these plants were longer in being counted than the preced-

ing ones, which were dibbled and drilled, and their advanced state in that time is an indication that plants sown in spring tiller very quickly, after braiding, in favourable weather.

3536. Taking the respective quantities of seed as having been sown on the square yard, both by Mr Hay and Mr M'Lagan, the quantities will be as follows on the acre:—

Grains.	Grains.
36 per sq. yd. =	174,240 = 1 peck per acre.
72	348,480 = 2
108	522,720 = 3
144	696,960 = 1 bushel
288	1,393,920 = 2
432	2,090,880 = 3
576	2,787,840 = 4
720	3,428,800 = 5
864	4,181,760 = 6

3537. Mr Kenyon S. Parker made a comparative experiment between drilling, dibbling, and broad-casting wheat on clover lea, and the results show little difference between the drilled and dibbled crop with Newberry's dibbler, the difference only consisting in the straw being longer and stronger, and the ears and grain bolder in the dibbled.

	bush. peck. the acre.	qr. bush. gal. the acre.	Weight per bush. lb.
Broadcast, 1 3 produced	3 7 1	62	
Drilled, { 1 2 ...	4 3 1	63	
at 12 in., {			
Dibbled, 1 0 ...	4 3 0	63½	

3538. Mr Thomas King Thedam, Little Braxted, Essex, made, in 1848, experiments upon wheat deposited in eight different quantities, dibbled at the same distance, each having 40 holes, upon a space of fourteen square feet, with these results—

No. of Grains in each hole.	Amount of Grains sown.	Rate of Grains per square foot.	Rate of Seed per acre.		Amended rate, according to the quantities given in (3536.)		Number of ears produced.	Weight, in- cluding straw and chaff.
			Pecks.	Pints.	Pecks.	Pints.		
1	40	3	1	3	0	14	67	12
2	80	6	2	6	1	12	97	16
3	120	8	3	10	2	10	157	26
4	160	11	4	12	3	8	170	26½
5	200	14	6	4	4	14	174	26½
6	240	17	7	3	5	4	242	40
7	280	20	8	6	6	2	224	36
8	320	23	9	9	7	0	222	38

"The produce of a sheaf of wheat grown last year, and weighing 12 pounds, was 4 pounds net, or one-third of the gross; this season 12 pounds gross produced only 3½ pounds net; therefore, as there are 43,560 square feet in the acre, only one ounce of wheat is required per square foot to produce 2,722½ pounds, which will amount by weight to something more than 42 bushels, at 64 pounds to the bushel. The foregoing experiment was made upon a gravelly soil, of a tenacious quality, and subject to grub and wireworm; and the crop that surrounded my experiments was from 6½ pecks of seed per acre, drilled with 10 rows upon a 7-foot stretch, and was in general appearance much better than any of that grown upon this thin-sowing system." This experiment indicates that the greatest result was obtained from 240 grains in the given space, which is here stated at 7 pecks 3 pints the acre; but as the number of grains in a given space is made to show a larger quantity of seed by Mr Thedam than the calculations of Mr Hay and of Mr M'Lagan make it, I have inserted a column of amended rates in the above table, by which the quantity of seed which produced the greatest result is altered to 5 pecks 4 pints, from 7 pecks 3 pints.

3539. The question to which these particular data give rise is, what quantity is too thick or too thin sowing, or what is the least quantity of seed that should be sown to yield the largest crop? The inquiry assumes much importance when we consider that from one-tenth to one-fourteenth part of all the grain grown in the country is every year put into the ground as seed. However small a fraction of either of these proportions could be saved by another mode of sowing, would increase the profit of the farmer to that extent. If one bushel of seed could be saved on the acre, the quantity of seed saved would amount to 2,403,198 quarters, according to the data furnished by Mr Couling to the House of Commons—the number of arable acres in the kingdom being 19,225,583—a quantity of grain considerably exceeding the annual import of foreign wheat for the long period from 1801 to 1844.*

3540. *Thick and thin sowing of seed*

have been much discussed and experimented on by several parties, but none has expressed himself so conclusively on it as Mr Hewitt Davis, London, and farmer of Spring Park, near Croydon, in Surrey. Mr Davis' farm contains 800 acres of high rented poor soil; but Scottish farmers should be made acquainted that this farm stands on a warm subsoil of chalk, an advantage which no farm of theirs possesses. Of his practice, Mr Davis says, that "the practice throughout England is to sow two or three bushels of wheat to the acre, and the yield seldom reaches 40 bushels, and more commonly less than 20 bushels, so that one-tenth at least of the crop grown is consumed as seed, whilst a single grain of wheat, planted where it has room to tiller out, will readily produce many hundred fold. The knowledge of these facts has induced me, in the course of the last fourteen years, to make a variety of experiments, the results of which have clearly shown me that, independent of the waste, a positive and serious injury of far more consequence is done to the crop from sowing so much seed. I bear in mind, that, if so much be sown as to produce more plants than the space will allow to attain to maturity, the latter growth of the whole will be impeded, and a diseased state will commence as soon as the plants cover the ground, and continue till harvest. In consequence, I have gradually reduced my proportion of seed-corn to less than a third of what it was my practice to sow; and this reduction I have accomplished to the very evident improvement of my crops." The quantities of seed which Mr Davis has at length determined on sowing, in accordance with these reasons, are, for—

Rye,	1½ bush.	sown in	Aug. and Sept.
Winter barley, 2	...	...	September.
Tares,	1½	...	{ three sowings in
			{ Aug. Sept. & Oct.
Oats,	6 pecks	...	{ Jan. Feb. March.
Barley,	5	...	{ Jan. Feb. March, and
			{ April.
Wheat,	3	...	Sept. and Oct.
Pease,	9	...	Dec. Jan. & Feb.
Beans,	9	...	Sept. and Oct.

It will at once be observed that the times of sowing here specified would not suit most of those crops in Scotland, and on this account alone the English farmer will always possess a great advantage over the Scottish. The results obtained by Mr Davis,

* Porter's *Progress of the Nation*, p. 188, 159.

after such scanty sowings, are 5 quarters of the best wheat, above 13 quarters of oats, and above 8 quarters of barley to the acre on "very inferior land," from the manure available on the farm.*

3541. Mr Mecli, of Tiptree Hall, Essex, continues his experiments of comparative sowing between one bushel and two bushels the acre, and the advantage is in favour of thin sowing, though the results are not uniformly in favour of it, the products varying from 3 bushels 3 pecks to one bushel the acre in favour of thin sowing, and half a peck the acre in favour of thick sowing. But it should be borne in mind that Mr Mecli's thick sowing is only 2 bushels the acre—a quantity equivalent to the thin sowing of many farmers.

3542. Mr B. Hunt, Basingstoke, tried an experiment of thick and thin sowing of wheat on clover lea, betwixt 6 pecks of seed to the acre, which produced 5 quarters the acre, and 10 pecks of seed, which not only produced 6 quarters the acre of grain which was 4 lb. the sack heavier, but half a ton of more straw. The results obtained by Mr Hunt have a tendency to uphold thick sowing, and he is therefore of the opinion that it is not safe to sow less than 7 or 8 pecks of good seed. As he does not mention the mode in which the seed was sown, I conclude it was the common mode of broadcast.

3543. The experience of Scotland as to thin sowing is as yet limited. Mr Hay of Whiterigg tried an experiment in the spring of 1848 with wheat after turnips, by sowing 1.4 bushel against 3 bushels the acre, and the result was that the thin sown gave a greater produce by a small quantity of straw and grain together, the chief advantage being in the saving of seed; but that the thick sown gave rather more than 2 bushels the acre more of grain, which was 1 lb. heavier the bushel.†

3544. Mr John Haxton, Drumnod, in Fifeshire, thus expresses himself on this subject:—"My own practice," he says, "used to be to sow 4 bushels of wheat after green crops, 5 bushels of early oats, 6 bushels of late oats, and 5 bushels of

barley per Scotch acre respectively, the Scotch being one-fifth larger than the imperial acre. More recently, however, I have curtailed these quantities by nearly a bushel per acre, and, so far as I can judge, with manifest advantage to the crops. The straw is much more bulky, and the grain decidedly greater in quantity; and, if sown early enough, quite equal in quality to what it was under the thick-sowing system. I am persuaded that, were I to drill the seed either with a machine or a plough, I could safely and economically dispense with another bushel per acre. While making these remarks in favour of thin sowing, I am not yet a convert to the English system of infinitesimal small quantities of seed, such as two or three pecks per acre, and can easily conceive circumstances under which this sowing would be positively injurious." Experience here also indicates the propriety of sowing in moderate quantity.

3545. On comparing the broadcast, drilled, and dibbled methods of sowing the cereal grains, from what has been said on the subject, it must be owned that the broadcast method, which is the most common one throughout the country, imposes a loss of seed by the harrowing, which not only leaves some of the seed exposed on the surface, but takes perhaps as many too deep into the soil. These effects are produced whether the seed be sown by the hand, (2316,) or by the broadcast machine, fig. 204, and cannot be avoided as long as the broadcast modes of sowing, as presently practised, are persevered in. I think it would be desirable could a plan be contrived of sowing grain broadcast at a uniform depth. It would be more economical than dibbling or drilling, inasmuch as the horse and hand-hoeing of the crop would be saved.

3546. A saving of one-tenth of the seed-corn is secured by using drilling or dibbling machines instead of the broadcast, and which of these should be chosen must be determined by other considerations than the proportion of plants produced by each, since both are nearly alike in that respect, from the thick as well as from the thin sowing.

* Davis *On the Waste of Corn by Too Thick Sowing*, p. 6-12.

† *Journal of Agriculture* for January 1849, p. 638.

3547. The drill does not work well in stony ground, it easily displacing the coulters, or the stones are displaced by the coulters, or the coulters ride over the tops of some of them; and where landfast stones or the subjacent rock lie near the surface, drills would be certain of being broken. The dibble is prevented penetrating into the ground by even a small stone, but perhaps no harm accrues to seed from depositing it upon stones under the surface of the ground. With the exception of such inconveniences, of which many instances might occur in Scotland, drilling or dibbling grain is preferable to sowing it broadcast as practised. One great advantage those possess is making the surface fine by harrowings and rollings, before the seed is sown, after which it is not disturbed in its position. Reference to figs. 289 and 290 at once shows that the deposition of seed at a uniform depth is more likely to produce a uniform crop than that at irregular depths and irregular distances, such as broadcast sowing necessarily deposits it.

3548. On the comparative merits of thick and thin sowing, experience has yet much to teach. The direct saving of seed effected by thin sowing recommends it at once for adoption; but if this advantage were all—unless the crop it produced were always good, of which there is no constant assurance—it would not produce a conviction of its superiority over thick sowing. In so doubtful a position we may safely take the middle course, of sowing a moderate quantity of seed; for I believe no doubt exists of very thick sowing, as hitherto pursued, having wasted a large proportion of the seed. In sowing, any more than in other practices of husbandry, no absolute rule will apply to all circumstances, and many considerations should be taken into account before a particular rule be adopted. I should say that farmers are, generally, blamable for the lavish manner in which they throw the seed into the ground, and subject themselves to considerable loss in sowing more seed than the most extreme conditions of soil and season warrant. The great evil of too thick sowing, is the crowding the plants together into a space where neither sufficiency of air or of room for their roots are provided. A struggle for existence between the plants commences after they have ar-

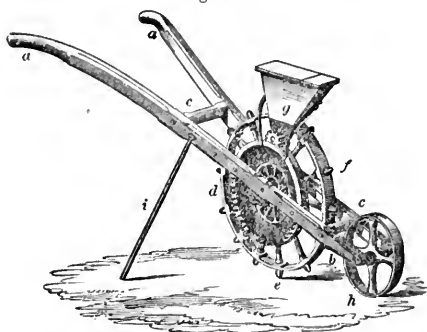
rived at the stage when their wants are of the most necessitous description; and the struggle terminates in the least vigorous ones dying off, and leaving the stronger, which would have been as numerous with thinner sowing, but which in consequence of the struggle have been much impeded in growth, and by which the ears and grains continue small, and yield a small return. Thick sowing is advisable on newly broken up land, containing a large amount of vegetable matter in an active state of decomposition, when it is beneficial in repressing, by its numerous roots and stems, that exuberance of growth which produces soft and succulent stems, that become lodged and produce unfilled ears. Thin sowing has a tendency to make the roots descend deep; and where a ferruginous subsoil exists, thick sowing keeps the roots nearer the surface, away from it. Thin sowing develops a large ear, grain, and stem, but delays maturity. Thick sowing on old land in high condition renders the plant diminutive, and hastens its maturity before the ear and grain have attained their proper size. Thin sowing in autumn affords room to plants to tiller and fill the ground in spring, while thin sowing in spring does not afford time for the plant to tiller much. Thick sowing in autumn makes the plants look best in winter, but it gradually attenuates them as the spring advances. Thin sowing makes them look worst in winter, but to become more full as the harvest approaches. You thus see that a moderate quantity of seed of the cereal grains is the most prudent practice to adopt generally; and where exceptional cases occur, as noticed above, the judgment must be particularly exercised; and after experience has certainly established the most proper quantity for every particular case, the difficulties of sowing will be removed, and its economical benefits realised.

3549. I have already described the mode of sowing grain broadcast, (2333,) and also in drill, (2339;) it now remains to describe the sowing of it with the dibble, which is done by manual operation or with machines. Dibbling may be performed by the hand with a hand dibbler as potatoes are in gardens, or with pins attached to the side of a long piece of wood, and thrust with the foot into the ground, or

with small hand dibbles, thrust through holes formed in a thin board of wood. In all these modes the seed is deposited into the holes so formed at stated distances of 7 inches between the rows, 4 inches apart in the rows, and $2\frac{1}{2}$ inches in depth, by the hands of boys and girls, and the earth is put over them with the foot. The cost of these modes of dibbling grain is from 5s. to 7s. 6d. the acre, and of pease and beans from 3s. 6d. to 4s. the acre.

3550. But machines will no doubt supersede hand labour in dibbling grain, should that mode of sowing be ultimately adopted, and they can do the work at one-third of the expense incurred by the hand. The dibbling machine first brought into notice, and which is yet the most perfect of its class, was invented by Mr James Wilmot Newberry, of Hook Norton, Chipping Norton, Oxfordshire. It is a very ingeniously constructed machine, and rather elaborate in its construction, which will always maintain its high price; but it deposits every kind of seed at given distances, in any quantity, with the utmost precision. Fig. 291 is a view in perspective of one of

Fig 291.



NEWBERRY'S ONE-ROWED DIBBLING MACHINE.

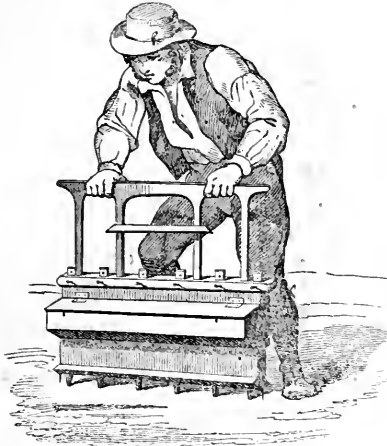
the forms in which this machine is made, being one-rowed. It consists of a hollow flat disc, *d*, which contains the machinery that directs the seed from the hopper *g* into the hollow tubes, *e*, 18 of which are connected with and project from the circumference of the disc *d*, like the spokes of a wheel from its nave, and their points pass through the larger outer ring *f*, which retains the hollow tubes or distributors of seed in their respective places, and prevents them sinking into the ground beyond the requisite depth. The fore wheel *c*, which

is placed between the extremities of the handles *a a*, prevents the large wheel *f* being pressed closer to the ground than is needful. A man pulls the machine forward by means of a rope attached to the stilts at *b*, or, what is better, a bridle and shackle might be mounted there, for yoking a pony or horse to draw the machine. As the wheel is drawn forward by the horse, it turns round by its action on the ground, the projecting points *e* of the hollow tubes acting as dibbles and making holes in the ground, one portion of which dibbles, before leaving the ground, slide upon the other half, making an opening through which the seeds are deposited in the holes. The seed descends to the requisite number, from the hopper *g*, by means of feeding-rollers, moved by the pinion, which is set in motion by teeth placed on the circumference of the disc *d*. The disc is supported in its centre by an axle revolving in its ends on plummer blocks. In using this machine, a man holds by the two stilts *a a*, while a horse draws the machine in the given line. This line not being in that of the drill, a rigger like that of the drop-drill, fig. 261, is here required for the horse to be yoked to. The stay *i* supports the machine when at rest. The price of the 5 and 7 rowed dibbles is £60, that of the one-rowed on wheels £13, and a hand one, without wheels, £6. This one-rowed dibble is said to be well suited for sowing mangold-wurzel seed on the top of the drill.

3551. Since then a dibbling machine has been presented to public notice by Dr Samuel Newington, of Knole Park, Frant, near Tunbridge Wells, in Kent. Fig. 292 is a view in perspective of one having six depositors: the box in front contains the seed, and the points of the depositors are seen to rest upon the ground, which has been harrowed smooth. The depositors are made to deposit the seed at the desired depths, elevating or depressing them, and keeping them in their places by pinching screws. The machine is worked by taking hold of the upper rail by both hands, and, on pressing upon it, the depositors, when withdrawn, leave the requisite number of seeds in each hole the depositors have made, by the machinery in the interior of the machine. By pressing down the upper handle, the depositors press every seed firmly into a solid bed, which is so small

as to preclude the fear of their containing water, and yet completely buries the seed. By changing the cups, the quantity of the seed is regulated, as well as the description of seed. With a machine having 6 depositors, a man can dibble an acre in 10

Fig. 292.



NEWINGTON'S SIX-ROWED DIBBLING MACHINE.

hours, which makes the cost about 2s. the acre. In using the machine after the first line is laid off straight next the fence, the workman continues to keep the other lines straight at the stated distance by the mark left on the ground by the machine. The seeds are put in at 4 inches apart in the rows, and the quantity is varied by either altering the distance between the rows, or increasing the number of seeds in each hole, but it is not desirable to exceed three seeds in each hole. The cups which contain the seed are of four sizes, and can be easily removed or replaced by means of screws. The price of a machine with six depositors, which is the usual size, is £2, 10s.

3552. When a man uses a small dibbler, a convenient mode of keeping the lines straight in sowing is this:—Take two long lines and stretch them along the side of the field to be sown, at a determinate distance between them; *a b* and *c d* are the two lines at a distance between them of *a c* and *b d*. Let him dibble in the seed along *a b*,

<i>a</i>		<i>b</i>
<i>c</i>		<i>d</i>
<i>e</i>		<i>f</i>
<i>g</i>		<i>h</i>
		<i>i</i>

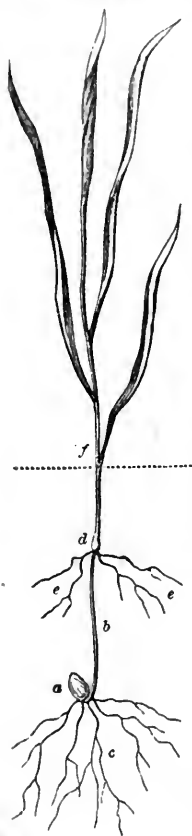
and, when at *b*, let him shift that end of the line from *b* to *f*, and then dibble the seed in from *d* to *c*, where, let him shift the end of the line at *a* to *e*, which brings the line straight from *f* to *e*. Before starting with the dibbling from *e*, let him remove the end of the line at *c* to *g*, and then dibble the seed from *e* to *f*, where he shifts the end of the line from *d* to *h*, which brings the line straight from *g* to *h*. Shifting the line from *f* to *i*, he proceeds precisely as he did when at *b*, and so on alternately from one side of the field to the other.

3553. Another circumstance which affects the relation between the seeds sown and the plants produced, is the depth to which the seed is buried in the ground. In ill-ploughed land, such as in fig. 286, seeds sown broad-cast falling between ill-assorted furrows, sink to the bottom of the furrow slice, where they are buried so deep as to become dormant or lose their vitality. Seeds are very differently affected by depth, some sorts germinating from a considerable depth, whilst others become dormant or die, if placed at a comparatively small distance below the surface of the ground. I have traced the stem of a plant of barley as far as 9 inches below the surface, from which depth it had penetrated the ground from the seed whence it sprung; while oats, buried 7 inches deep in the soil, will die. This accounts for the absence of oats, which have slipped down between the furrow slices of lea, where they perish. The risk of thus losing the seed sown on old lea, the furrow-slices of which are difficult to be laid close to each other in ploughing, induced me to recommend the partial harrowing of the surface of ploughed old lea before the seed is sown, (2491.) The roots of barley strike downwards a considerable depth, which indicates that barley-seed should have a deep seed-furrow, as I recommended in (2689); but the roots of oats spread and keep near the surface, like those of the Scots fir and the beech, and hence oats thrive better upon shallow ground than barley.

3554. Wheat possesses a property in its roots common to both barley and oats. The seed will bear to be deep sown—not so deep as barley, but deeper than oats, and not deeper than 6 or 7 inches; and

after the germ has become a stem, it puts out another set of roots about an inch below the surface. The deeper may be called the *seminal*, and the upper the *coronal* root of the wheat plant. Fig. 293 shows the arrangements of the roots under the surface, where *a* is the seed with its seminal roots *c*, and the germ *b* rising from it to the surface of the ground at *f*, above which the stem, with its leaves, are seen. About an inch below the surface at *d* are formed the coronal roots *e e*, the office of which is not only to maintain the plant, but to form the site from which the multiplication of the plants proceeds when it sends forth its tillers. At whatever depth the seed may have been sown, from 2 to 5 inches, the coronal roots are formed at one inch at *d*, the difference being the length of the connecting tube *a b*, according to the depth the seed had been deposited.

Fig. 293.



THE DOUBLE ROOTS OF DEEP SOWN WHEAT.

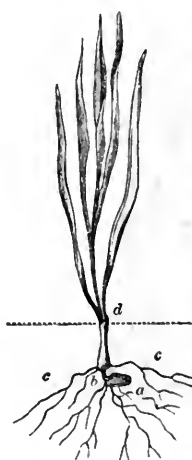
a b, according to the depth the seed had been deposited.

3555. "As the increase and fructification of the plant depends upon the vigorous absorption of the coronal roots, it is no wonder that they should find themselves so near the surface where the soil is always the richest. I believe I do not err when I call this *vegetable instinct*. In the northern counties wheat is generally sown late. When the frost comes, the *coronal* roots, being young, are frequently chilled. This inconvenience may, however, be easily prevented, by sowing more early, and burying the seed deeper. The seminal roots

being out of the reach of frost, will then be enabled to send up nourishment to the crown, by means of the pipe of communication."

3556. Now the form which the plant

Fig. 294.



assumes, when sown near the surface, is different from this, and is seen in fig. 294, where *a* is the seed with its seminal roots; *b* the pipe of communication between them and the coronal roots *c c*, which are a little beneath the surface *d*. The coronal root *c* being at a less distance before, the pipe of communication is shortened to the smallest longitude. "Hence it is obvious," continues the same writer, "that

SHALLOW SOWN WHEAT. wheat sown superficially must be exposed to the frost," while the life of the plant is placed in jeopardy "from the shortness of the pipe of communication," placing the seminal root within reach of the frost. The plant, in that situation, has no benefit from its double root. On the contrary, when the grain has been properly covered, the seminal and coronal roots are kept at a reasonable distance. The crown, being well-nourished during the winter, sends up numerous stalks in spring. On the tillering of the corn the goodness of the crop principally depends. A field of wheat dibbled, or sown in equidistant rows by the drill, always makes a better appearance than one sown with the harrow. In the one, the pipe of communication is regularly of the same length, but in the other it is irregular, being either too long or too short."*

3557. The conclusions which the foregoing statements warrant are evidently these:—that the wheat sown before winter should be as deeply covered with earth as to be beyond the reach of injurious frost, say 4 or 5 inches; that in spring the coronal roots will set out from the estab-

* *Georgical Essays*, vol. i. p. 67-9.

lished plants abundance of tillers or stools; that wheat sown in spring should be lightly covered, little exceeding one inch; that the tillers or stools will be few; that therefore the autumn wheat ought always to be dibbled or drilled to make the pipes of communication long, and of uniform length; that spring wheat may be sown broadcast; and that autumnal sown wheat should have less seed than that sown in spring.

3558. Depth of sowing affects no plants so sensibly as the grasses. The late Mr Stirling of Glenberrie, near Falkirk, made the following experiments to ascertain the depth which the common grass and

clover seeds should be covered, to produce the greatest number of plants. The same weight of seed was sown of each kind, and as different seeds differ in bulk and weight, the numbers of each kind differed materially. I think the better plan would have been to have sown the same number of seeds of each kind, and the proportion which came up of the plants would have been more easily ascertained than by the method adopted by Mr Stirling. Each kind of seed was covered from a quarter of an inch to three inches of depth in the soil. They were sown on the 1st of July and counted on the 1st of August 1844.

KINDS OF SEEDS EXPERIMENTED ON.	No. of seeds sown altogether.	COVERED AT												No. of plants that came up.	Proportion of plants that came up.
		1/4 inch.			1/2 inch.			3/4 inch.			1 inch.				
		1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3		
Perennial rye grass, <i>Lolium perenne</i> ,	348	29	30	27	19	16	19	14	21	11	9	8	4	198	.57
Italian rye grass, <i>Lolium italicum</i> ,	276	24	21	20	13	13	10	11	8	9	6	5	5	145	.51
Cocksfoot, <i>Dactylus glomerata</i> ,	300	30	22	15	15	10	9	7	5	2	..	..	..	115	.38
Large fescue, <i>Festuca ciliaris</i> ,	312	20	24	20	16	13	13	11	9	4	2	1	..	142	.42
Meadow fescue, <i>Festuca pratensis</i> ,	324	28	28	16	12	10	6	9	4	2	2	..	..	117	.36
Varied leaved fescue, <i>Festuca heterophylla</i> ,	348	31	23	20	18	12	9	6	4	1	..	..	..	124	.35
Hard fescue, <i>Festuca duriuscula</i> ,	300	30	23	10	15	10	8	5	3	1	..	..	..	114	.38
Meadow Fox-tail, <i>Alopecurus pratensis</i> ,	192	17	17	16	15	12	7	6	3	1	..	..	..	94	.49
Timothy grass or Meadow Cats'-tail, <i>Phleum pratense major</i> ,	528	52	39	37	19	16	15	7	5	0	..	..	..	190	.36
Evergreen wood meadow grass, <i>Poa nemoralis sempervirens</i> ,	228	24	14	4	1	..	..	..	..	..	..	..	..	43	.18
Rib grass, <i>Plantago lanceolata</i> ,	252	22	25	19	17	14	11	10	8	6	2	..	..	134	.53
Red clover, <i>Trifolium pratense</i> ,	192	17	16	14	11	11	8	4	4	..	..	..	..	85	.44
White clover, <i>Trifolium repens</i> ,	144	13	11	6	4	3	1	..	..	..	..	..	..	38	.26
Yellow clover, <i>Medicago lupulina</i> ,	96	12	10	8	6	4	2	..	..	..	..	..	..	42	.43
*	3900	358	303	241	181	144	118	90	65	37	21	14	9	1581	.40

It will be seen from this table that in only three cases did the number of plants come up exceeding one half of that of the seeds sown, the largest proportion being in that of the perennial rye grass—the average of the whole being under one half, viz. .40. The clovers came up in a small proportion, particularly the white, which is generally considered a hardy plant in this climate. The rye grasses came up much better than the clovers. Of the depths, the quarter of an inch covering gave the largest return of plants, and 16 per cent more than half an inch; and to show that the quarter of an inch is the most favourable depth for all the seeds, most of them gave more plants than the seeds sown, which indicates a tillering from the roots before the germ had penetrated the soil; and this

may have been induced in the young roots, from the seeds having been sown in soil in a green-house, where the temperature would be more conducive to reproduction than that of the open air. This experiment, therefore, though evidencing much loss of seed, shows a more favourable result than should be expected in the field.

3559. The scanty braird obtained from the large number of turnip seeds sown, there being about 292,600 seeds of swedes sown in the double drill on every acre, while only 19,360 plants are required, it has frequently occurred to me that many of the seeds are buried too deep in the drill by the coulters, and that this circumstance might account for the want of sufficient

* Transactions of the Highland and Agricultural Society, for January 1845, p. 341.

braird on strong soils in unfavourable seasons, for even that small number of plants. This point cannot be exactly ascertained in ordinary times, as it requires the concomitant circumstances of strong soil and an unfavourable season in which to conduct the experiment; but I made an experiment in the summer of 1849, in June, to ascertain the effects of deep sowing in comparison with shallow in the most favourable circumstances for vegetation—a free soil cherished in the high temperature of a vinery. Seeds of swedes, yellow Aberdeen, and white globe turnips were experimented on, 40 of each of which were placed in friable soil taken from under fine old pasture, at 1, 2, 3, and 4 inches in depth in pots, at 8 o'clock in the evening of the 6th of June, and the plants came up at the time and in numbers as follows:—

		SWEDES.				
		Inches in depth.	Plants came up.	In days.	Hours.	In proportion.
From 40 seeds	1	31	4	12	.77	
...	2	29	5	18	.72	
...	3	20	6	21	.50	
...	4	10	8	18	.25	
YELLOW ABERDEEN.						
...	1	28	4	10	.70	
...	2	25	4	18	.62	
...	3	14	5	18	.35	
...	4	5	8	14	.12	
WHITE GLOBE.						
...	1	22	4	10	.55	
...	2	18	4	13	.45	
...	3	12	7	0	.30	
...	4	7	7	13	.17	

On comparing these results there will at once be seen the large proportion of plants produced by the seeds sown at 1 and 2 inches in depth, compared with those at 3 and 4 inches. The proportion at 4 inches was so small that it is quite possible that if the experiments had been conducted in the open air, instead of in a warm vinery at a temperature of about 75° Fahrenheit, no plants would have appeared at all, since those which did appear were quite puny. Of the kinds of seeds sown, the swedes gave the most vigorous plants, these being always the largest sized seed. Of the other two kinds, the white globe gave generally the weakest, being the smallest sized seed, though the yellow Aberdeen showed

greater weakness than it in penetrating from 4 inches in depth. The conclusion I would draw is, that the seeds of the swedes should *not be sown deeper* than 3 inches, those of the yellow Aberdeen 2 inches, and of the white globe 1½ inch.

3560. The property of the cereal plants to *tiller* or *stool*—that is, to send up a number of stems from the same root—is a valuable one in an economical point of view. But for this property, when the seeds of the cereals happened to be much destroyed by insects under ground, or by the unfavourable state of the ground or of the air for vegetation, or from the destructive effects of frost, or when the young plants are destroyed by insects as they appear above the surface, the crop would be so scanty on the ground that it would most probably be ploughed up by the farmer as profitless, and another substituted in its stead. The extent of tillering depends on the circumstances of soil, weather, and the space allowed the plant to grow in. A free soil, admitting the shoots of the radicles to penetrate easily, encourages tillering, other circumstances being equal, more than a stiff hard soil. The weather when moist and warm promotes tillering. Unless plants have space for their roots, or are crowded together, they will not tiller. Tillering implies an instinctive faculty in plants to take advantage of all the food that will support them, and it is strikingly exemplified in the stronger plants in a crowded state, overcoming and killing the weaker ones.

3561. When the cereal plants find abundance of room in which to shoot their radicles around, they do so vigorously, with an apparent determination to occupy it to the exclusion of other plants; but when they are not crowded together, and are not more numerous than to occupy the ground fully, they exhibit no tendency to tiller. The question which such an observation gives rise to is, Whether it is better to allow few plants to fill the ground by tillering, or to fill the ground at once with the requisite number of plants? The answer to this question must be given conditionally. In naturally fertile soils, and in those rendered fertile by art, tillering will take place, and should be encouraged, as the straw and ears of tillered plants are much stronger and larger than those of single ones. In such a condition of soil, a small quantity of seed will, therefore, suffice, even in early spring, as it is in that season alone that tillering takes place in a sensible degree; but then the seed must not be sown so deep, or so late, as to deprive the plant of the time required by its tillering to occupy the ground fully. The extent of tillering is sometimes remarkable. Colonel Le Couteur mentions a downy variety of wheat which tillers to the extent of 32 plants,* and from 5 to 10 stems are a very common tillering for ordinary varieties of wheat. Barley has also tillered as much as wheat, though generally this species of

* Le Couteur *On the Wheat Plant*, p. 29.

grain shows less tendency to do so than either wheat or oats, the last indicating fully as strong a tendency as wheat. In weak soils, and in those in low condition, the tendency to tiller is much checked, each plant being as if conscious of the inability of the soil to support more than itself. Hence the practice is to sow more seed in low than in high conditioned land, and yet ability to support the larger quantity of seed is just the reverse. Still, what can the farmer do than afford the soil as much seed as will certainly produce as many plants as will occupy the soil fully? It would be imprudence in him were he to act otherwise, though a large proportion of the seed should be ultimately lost. The best way for him to escape from such a dilemma is to put the soil in high condition, and reap the advantages derivable from tillering.*

3562. The great loss in plants compared to the numbers of seed sown, may be accounted for from natural causes. Birds pick up seeds exposed on the surface after broadcast sowing. Many vermin, such as the rabbit, devour the young germ as it penetrates the soil, and many insects subsist in the grub state on the stems and roots of young plants; but I suspect that most of the seed destroyed is so by insects before it germinates. We have seen how much of the ingredient of the seed is converted into grape-sugar, just at the germination of the radicle (3512;) and as every living animal is fond of sugar, it is natural in the very numerous coleopterous insects which inhabit the soil, especially in spring, when the insect creation generally bursts into active life, to revel on the large quantity of sweet food presented to them at the time they are most in want of food—in the grub state. The myriads of voracious grubs existing on the grain sown, cannot but have a sensible effect on the limited quantity consigned to the soil. Were it not for the quickness of germination and vegetation, it is quite possible that all the seed sown might thus be devoured; and accordingly we find that, whenever the weather is such as to retard germination, the largest quantity of the seed is lost, even although that state of weather also tends to retard the development and suppress the numbers of the insect race.

3563. A mode of drilling wheat similar in effect to ribbing with the small plough, (2628 and 2630,) is accomplished with the *common plough and a single horse*, and, if necessary, any species of dry manure may be deposited in the furrow. The seed is dropped out of a hopper placed in the bosom of the plough, the quantity of which is regulated by a grooved axle, made to revolve by a small wheel, which receives its motion by being carried along the ground with the plough. The immediate effect of the operation is to cover the seed-wheat with the plough-furrow, which prevents its being thrown out by the frost in spring in soft and spongy land, and to cause the crop to grow in rows 9 inches apart. The pulverised manure is sown at the same time and in

the same manner as the seed, out of the same hopper, in which a division is made to separate the seed from the manure; and both fall through spouts, one placed behind the other. The advantages resulting from this mode of sowing wheat on spongy soil are, that the horse does not tread on the seed, and the seed requires no covering in with the harrow; but the state of the soil for which this method of sowing is adapted would be entirely changed by thorough draining.†

3564. A mode of saving seed to a greater degree than by dibbling and drilling, is by *transplantation*. This is done by sowing a small portion of ground with seed early in the season, taking up the plants as they grow, dividing them into single plants, and transplanting them. By thus dividing the plants, as they tiller into single plants, at four periods of the season, a very small quantity of seed will supply as many plants as would cover a large extent of ground. Though wheat no doubt bears transplanting very well, yet as the scheme implies the use of much manual labour, it is questionable if it will repay the expense. The proposed method has been tested by experiment, and the question of comparative expense stands thus:—Suppose 440 grains of wheat are sown on the 1st of July, and, on the supposition that every seed germinates, by the beginning of August each seed will afford 4 plants, or in all, 1,760 plants.

At the end of August these will produce	5,280	...
In September these again	14,080	...
And in November these last will produce	21,120	...

The time occupied in sowing the 440 grains, and dividing and transplanting the produce of them, stands thus:—

		Hours.	Min.
July sowing, } 440 grains		0	20
August beginning, } taking up 440 plants,		0	20
.. dividing into	1,760	..	1 10
.. planting	1,760	..	3 30
August, end, taking up	1,760	..	1 28
.. dividing into	5,280	..	3 30
.. planting	5,280	..	10 33
September, taking up	5,280	..	4 24
.. dividing into	14,080	..	9 23
.. planting	14,080	..	28 9
November, taking up	14,080	..	11 44
.. dividing into	21,120	..	14 4
.. planting	21,120	..	42 14
			<hr/>
		130	49

Equal to 13 days, 4 hours' work, at 10 hours a day. Of these say 13½ days, 5 days may be reckoned for women and boys occupied in taking up and dividing the plants, which, at 10d. per day, will cost 4s. 2d. The remaining 8½ days are for men transplanting, at 10s. per week, or 1s. 8d. a day, which will cost 14s. 2d. more; both 18s. 4d. per acre. The seed for the plants, half a bushel at 44s. the quarter, or 5s. 6d. the bushel, would cost 2s. 9d. The entire cost would be £1, 1s. 1d. The saving of seed from the ordinary quantity sown would be the difference of cost between half a bushel and three

* *British Farmers' Magazine*, No. vi. old series, p. 15, 1827.

† *Mark Lane Express* for November 24, 1842.

bushels, or 13s. 9d. So that the loss on the transplanting over sowing would be 7s. 4d. "In my opinion," says Mr Palmer, the experimenter, "the only way of executing this plan is to dibble in the seed, 2 grains in a hole, about 4 inches from each other, the plants to be taken up when they are in a proper state, and divided into 5, which would be as many on an average at that time as could skilfully be made, and then planted out at once, where they are to remain, thus getting rid of all the intermediate dividings." *

3565. Suppose this method were adopted, the number of grains of wheat required for 1 rood would be 391,040, which would be about half-a-bushel, at a cost of 2s. 9d.; and, consequently, about half-a-bushel of wheat will plant 195,520 holes. If each hole gives 5 plants on an average, which may be reasonably expected, there would be at the disposal of the farmer about 977,600 plants, a quantity sufficient to plant 3 acres at 18 inches apart. To limit the time for planting so many plants, suppose they are taken up, separated, and planted again by, say, 25 persons taking up, dividing, and supplying 25 planters, in all 50 persons, and allowing each planter to plant 5280 per day—suppose it wholly done by boys and girls at 6d. per day—they would take 7 days to do it in. The cost of transplanting the 3 acres would thus be £8, 15s. Wheat-seed for 3 acres, sown in the usual way of 3 bushels to the acre, would cost £2, 9s. 6d. at 44s. the quarter.

The whole matter would stand thus:—

Cost of half bushel of wheat, . . .	£0 2 9
Cost of dibbling quarter of acre, . . .	0 1 3
Cost of transplanting 3 acres, . . .	8 15 0
	£8 19 0
Cost of sowing 3 bushels of wheat, . . .	2 9 6
Loss on transplanting 3 acres, . . .	£6 9 6

Or £2, 3s. 2d. the acre.

ON REPAIRING THE FENCES OF PASTURE FIELDS.

3566. Having placed in the ground the seeds of all the crops which will be matured in the course of the following autumn, we must now bestow some attention on the treatment, during summer, of the live stock, for whose special use are those crops of roots, and straw, and forage, the culture of which has hitherto occupied our time and skill. The live stock are supported in summer chiefly on pasture grasses and forage plants. We shall first consider the management of pastures, as they come first into use, and then we shall treat of the forage plants; but before

taking possession of the pasture fields, it is necessary to inspect the state of the fences enclosing them, and to put them into such repair as to offer no temptation to the stock to scramble through neglected gaps, to the injury not only of the fence, but of themselves. Sometimes a good deal of work is required to put grass-fields in a proper state for the reception of stock, owing principally to the nature of the soil, and partly to the state of the weather.

3567. On every kind of soil, the small stones lying upon the pasture should be gathered by the field-workers, and carted away for the use of drains, or to be broken into metal for the farm-roads. It may happen that the throng of other field-work may prevent the assistance of horses and carts being given for this purpose, in which case the stones should be gathered together in small heaps upon the furrow-brow of every other single ridge; but in doing this, it should be remembered that many such heaps of stones occupy much ground, and, of course, prevent the growth of as much grass, so that it is much better practice to cart them away at once, although the gathering should be delayed for a few days, and even after the stock have been put into the fields. When carts are used, the stones are thrown directly into them; whereas, in making heaps, they require to be carefully put together, which wastes time, and they have to be removed after all. Some farmers are regardless of gathering the stones from the grass-fields to be pastured; while all acknowledge that those for hay ought to be cleared of stones to save the scythes from injury when cutting the grass. On clay soils few or no stones are found, and in wet weather no cart should be allowed to go, or stones be gathered, on new grass on any soil.

3568. Every field, whether of new or old grass, should be rolled with the smooth roller, fig. 222, some time before the stock enter it; and it is clear that the ground cannot receive all the benefits of rolling as long as stones are allowed to remain on its surface. The best time for rolling is when the surface is *dry*, not when *hard* as well as *dry*; for when grass, particularly young grass, is rolled in a

wet state, it becomes bruised and blackened, but, when dry, it is elastic, and able to bear the pressure of the roller without injury. Light land will bear rolling at any time when the surface is dry; but plants are liable to be bruised at all times between the roller and hard clods on clay land, and such land in a soft state becomes hardened or encrusted by rolling. The rolling of heavy land thus requires consideration; but a good criterion of its being in a fit state for the roller, is when the clods crumble easily with the pressure of the foot, and do not press flat, or enter whole into the soil. The rolling is always given *across* the ridges, (2475.) After rolling, the grass is found to grow rapidly, if the weather is at all favourable.

3569. While the surface of the field is thus preparing for the reception of stock, the hedger should be engaged in repairing the fences of thorn hedges. In this he is frequently assisted by the shepherd, and in case of no professed hedger being on the farm, the shepherd himself undertakes the duty. The repairing chiefly consists in filling up gaps, which are rendered fencible by drawing a thorn branch between the hedge roots, or by driving a couple of stakes into the face of the hedge-bank behind the gap, and nailing 2 or 3 short rails on them, or in wattling them with branches of trees or of thorn, or by setting a dead hedge upon the hedge-bank. There should nothing be placed in the gap, as is often done, to the prevention of the lateral extension of the thorn-plants on either side to fill it up, which the shoots will do in time in a narrow gap. A wide gap may require to be filled up with living plants, or with layers from the hedge on both sides. Every gateway in a field, not required for the season, should be filled up with a dead hedge.

3570. Stone-fences should be repaired by a dry stone mason, and all they require is chiefly the replacing of some cope-stones, and the rebuilding of any stones in the walls, that may have been driven down by violence. It is seldom that the stones so driven down will repair the dilapidations, so that a few fresh ones should be laid down at the gaps for the use of the mason. Every gateway not required for the season should be built up.

The stones left on making the repairs should be immediately removed.

3571. In making repairs in all sorts of fences, it should be borne in mind to keep a passage for the shepherd from field to field when looking after his flock. Such facilities are afforded by leaving small openings at the corners of fields, or by placing wooden stiles across the fence; and it is better for the fences that these are made at once, than that the shepherd should have afterwards to make them for himself. He is the best judge of where they should be placed, in the short cuts to be taken from field to field.

3572. Besides the fences, the *gates* of grass-fields require inspection and repairs, so as they may be put into a useful state for the season. When a post is broken, or a bar wanting, a new one should be supplied by the carpenter, and the iron-work should be repaired by the smith.

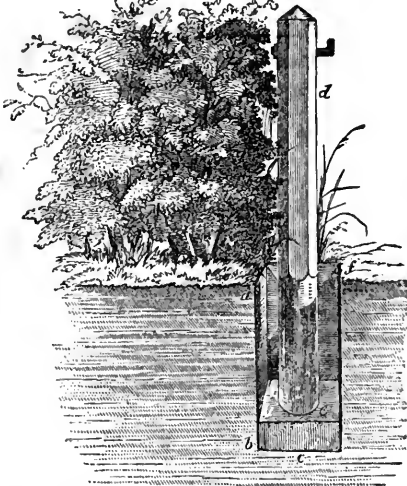
3573. The most convenient position for a gate, for easy entrance into and egress from a field, is at the end of one or both headridges, which are always regarded as the boundaries of fields.

3574. Field-gates should always be made to fold back upon a fence, to open beyond the square, and not to shut of themselves. When they shut of themselves, and are not far enough pushed back when opened, they are apt to catch the wheel of a cart when passing, and to be broken, or the post to be snapped asunder by the concussion; and as self-shutting gates are often left unfastened by people who pass through them, requiring greater attention than is usually bestowed on such matters, the stock, particularly young horses, which seem to take delight to loiter about gates, would then escape from the field. Young horses loiter about gates to rub against them, to prevent which it is necessary to wattle thorns into the bars.

3575. I have found an excellent plan of fixing a hanging post is to dig as narrow a hole as is practicable for the purpose, 3 feet deep, and at the bottom lay a flat stone of about 15 inches square, and 7 or 8 inches thick, through the centre of which is cut a hole of 8 or 9 inches in

diameter, to take in the lower end of the post, dressed with the axe to fit the hole. Earth alone is then put in spadefuls into the hole, and made firm around the post with a rammer up to the surface of the ground, in which is sunk the stone, at the edge of the upper face of which the heel-post of the gate is made to rotate in a shallow hollow made to fit it. Fig. 295 shows the different

Fig. 295.



SECURE MODE OF FASTENING THE HANGING-POST OF A FIELD-GATE.

parts of this mode of fastening the hanging-posts of field-gates; where *ab* is the hole into which the post *d* is sunk, and *c* the stone in the hole *e*, of which the end of the post is inserted and secured. Water passing through the stone, the end of the post will be preserved; and further so by being in the bark, smeared with coal tar, and the upper part *d* is planed and painted. The earth is rammed hard into the pit *ab* to the surface of the ground, in which is sunk at *f* a stone, on which the heel-post of the gate rotates. Part of the hedge fence of the field in which the gate is placed is shown, as also the crook on which the gate is hung, in the gate-post above *d*.

3576. Every pasture-field should be provided with one good *rubbing-post* standing 6 feet in height above the ground. It should not be so rough as to injure the skins of the animals, or so smooth as not to titulate the skin. Perhaps the best material for a rubbing-post is the trunk

of a spruce tree, with the branches sawn off square, not quite close to the trunk, and the stubs thus left are rubbed smooth by scratching.

ON THE DISPOSAL OF THE FAT SHEEP.

3577. When last treating of sheep, in regard to the lambing of ewes, we left the ewes and lambs upon the young grass, (2555,) at which time the sheep were feeding on turnips, in the manner described in the early part of winter (940); and they continue there until all the turnips allotted to them are consumed.

3578. When the turnips allotted them are all consumed, and the time has arrived for the last of the turnip land to be ploughed up for barley, (2685,) the *hogg*s receive a change of treatment. The *wether-hoggs* are either sold to the dealer off the turnips, or put to grass till shorn of their wool, and then disposed of. The circumstance that determines which of these ways they should be treated, is the state of the wool and mutton markets. If you find, on examination, that the *hoggs* are in a condition to realise as much money off the turnips as they probably will, after being kept a month longer on grass, and washed and shorn, it is more profitable to dispose of them at once; and besides this, should you fear the extent of grass to prove insufficient to support them in improving condition till they are shorn, a necessity exists for parting with them immediately off the turnips. But should you find the grass able to maintain them in condition, and that the wool market will probably be brisk, it would be advisable to retain and shear them.

3579. If you determine on selling the *wether-hoggs*, you should first ascertain their value; and in attempting this you will perceive, that a sheep wearing its coat of wool cannot be subjected to the ordinary rules of measurement; nor can its true weight be found by weighing it alive, since the weight of the wool enters as a disturbing element into the calculation, and the value of that material depends on very different circumstances from that of mutton. A new-shorn sheep may be either weighed or measured, and its

value ascertained very nearly. The eye and the hand alone must be employed to judge of the value of a rough sheep, and no more certain way of acquiring a correct judgment of the weight exists than by handling it, except by slaughtering one of average size and weighing the four quarters.

3580. Hogs, when put on turnips in winter, are generally lean; for although they had been in good condition as lambs when weaned from their mothers in summer, their growth in stature is so rapid, that their flesh is but little intermixed with fat. For the first few weeks on turnips, and in the most favourable circumstances as to quality of food, warmth of shelter, dryness of land, and pleasantness of weather, they make no apparent advancement in condition; they rather seem to fall off, the wool looks collapsed, and indicates a tendency to delicacy in the sheep, in consequence, I suppose, of the turnips operating medicinally on their constitution as an alternative, if not as a laxative. But immediately after that trying period for young sheep, particularly trying in bad weather, has passed, when the grass has been got rid of, and the stomach and intestines have become accustomed to the more solid food of the turnip, their improvement is marked, the wool seems longer and fuller, the carcass fills out, the eyes become clear and full, and the gait firm and steady. They then thrive rapidly, and the more so the drier the weather.

3581. The formation of fat in a sheep placed to be fattened, commences in the inside, the *net* of fat enveloping the intestines being first formed, and a little fat deposited around the kidneys. After that, the fat makes its appearance on the outside, and first upon the end of the rump at the tail-head, whence it moves along the back, on both sides of the back-bone, to the neck, spreading out to the bend of the ribs. It is then deposited between the muscles, parallel with the cellular tissue. Meanwhile it is covering the lower round of the ribs descending to the flanks, until the two sides meet under the belly, from whence it proceeds to the breast in front, and to the cod behind, filling up the inside of the fore legs and thighs. While all these depositions are proceeding on the outside,

the progress of the inside has increased, until a fattening disposition has been encouraged by the acquired condition; and the result is, that the space between the intestines and loin is filled up with net and kidney fat. By this time, the cellular spaces around each fibre of muscle has received its share, and the fat deposited there in quantity gives the meat the *marbled* appearance. The interfibrils spaces are the last to receive the fat; but after the deposition has begun, every other part simultaneously receives its share, the back and kidneys receiving the most, the former becoming *nicked*, that is, the fat is felt through the skin to be divided into two portions, from the tail-head along the back-bone to the top of the shoulder, the tail becoming thick and stiff, the top of the neck broad, the lower part of each side of the neck towards the breast full, and the hollows between the breastbone and the inside of the fore-legs, and between the cod and the inside of the thighs, completely filled up. When in this state, the sheep is said to be *fat* or *ripe*.

3582. When the body of a sheep is entirely overlaid with fat, it is then in the most valuable state as mutton; but few sheep lay on fat equally over their body—one lays the largest proportion on the rump, another on the back, a third on the ribs, a fourth on the flanks, a fifth on the parts adjoining the fore-quarter, a sixth on those of the hind-quarter, a seventh lays on more fat on the inside, and an eighth more on the outside. Out of so many parts, combining any two or more together, you may expect to find, in a lot of fat sheep, a considerable variety of condition; yet any one sheep is as ripe in its own way as any other.

3583. Taking these data for your guide, you will be able, by handling, to judge the condition of a sheep in its progress towards ripeness. A *ripe* sheep, however, is easily known by the eye, by the fulness exhibited in all its external parts. It may exhibit a deficiency of fat in some parts, but you easily perceive that those parts will never become so ripe as others; and the deficiency arises no doubt from some *constitutional* defect in the animal, because, otherwise, no reason should exist why every part should not be alike ripe. The condi-

tion of a sheep obviously not ripe cannot altogether be ascertained by the eye: it must be *handled*—subjected to the scrutiny of the hand. Now the hand scrutinises by discretion. A full-looking sheep need not be handled on the rump, as it would not seem full elsewhere until fat had been deposited there. A thin-looking sheep should be handled on the rump; and, if no fat is felt there, it is useless handling elsewhere, since none exists. Between these two extremes of condition, every variety may be met with; on which account examination by the hand is the rule to judge a fat sheep, that by the eye alone the exception; but the hand is much assisted by the eye, whose acuteness detects deficiencies and redundancies at once. In handling a sheep, the points of the fingers are chiefly employed, and the accurate knowledge conveyed by them, through practice, of the real state of the condition is truly surprising, and conveys a conviction to the mind of an intimate relation existing between the external and internal condition of an animal. So intimate is this relation, that the practical maxim, in the judging of stock of all kinds, has long been established, that no animal will appear *ripe to the eye*, unless as much fat had previously been laid on in the inside as its constitutional habit will allow. The application of the rule is easy—whenever fat is seen or felt on the outside, the inside had previously received a deposition. In tracing the progress of the fat on the outside, a relation also exists between the parts. Thus, when you find the rump nicked on handling, you expect to find fat on the back; when you find the back nicked, you expect the fat to have proceeded to the top of the shoulder and over the ribs; and when you find the top of the shoulder nicked, you expect to find fat upon the neck, and on the under side of the belly. To ascertain its existence below, you will have to *turn* the sheep, which is done by setting it upon its rump, with its back inclining against your legs, and its hind-feet pointing upwards. In this position you feel and see whether or not the breast and thighs are completely filled up. Still the criterion to know the real state of the inside of the sheep—the largeness of the mass of fat on the kidneys, weight of net, and thickness of layers between the abdominal

muscles—is the thickness of the flank, the fulness of the breast, fulness from shoulder to shoulder across the neck; stiffness and thickness of the root of the tail, and breadth of the back of the neck. Hence the sole object of feeding sheep on turnips is to lay *fat* upon every bundle of fleshy fibres, called muscles, which are capable of acquiring it; for as to bone and muscle, these increase in weight and extent independently of fat, and fat only increases the thickness of the muscles.

3584. I have spoken of the *turning* of a fat sheep, which is done in this way. Standing on the *near* side of the sheep, or *its* left side, put your left hand under its chin, and seize the wool there, if rough—if otherwise, the skin; place your knees, still standing, against its ribs, then lean forward a little, extend your right arm over the far loin of the sheep, and get a firm hold of its flank, by the wool and skin, as far down as you can reach. Lift the sheep fairly off the ground, with the assistance of your arms and knees, and then turn its body towards you upon your left knee placed under its near ribs, and drop it upon its rump on the ground with its back to you, and its hind-feet sticking out and away from you. This is an act which really requires strength, such that, if you cannot lift the sheep off the ground, you cannot turn it; but practice teaches a sleight in doing it, beyond mere physical strength. The art consists in jerking the sheep off its feet at once, before it suspects what you are going to do; for, when it suspects, it is surprising how it contrives to retain hold of the ground with the point of the hoof of the *near hind-foot*, which, if you cannot lift off the ground, you cannot turn the sheep. I remember seeing four shepherds defeated in the attempt to turn 5 dimmons belonging to the late Mr Edward Smith, Marledown, Northumberland. None of them, not even the tallest and strongest, could turn all the 5 sheep, and one, a short, stout man, could not turn one of them. The ability to turn a sheep easily, is not to be regarded as a feat of strength or dexterity in a shepherd, but a necessary qualification in connexion with many important operations connected with the management of sheep.

3585. The *ewe* hogs are always retained

on the farm, as from them is supplied the waste of ewes, and they are shorn of their wool in due course of time. It is of less importance increasing their condition off the turnips by putting them on the best grass, which the wether hogs should occupy until they are disposed of. Nevertheless, the ewe hogs should not be allowed to fall off in condition, in case of injuring the quality of their wool.

3586. Farmers of mixed husbandry have seldom any other class of sheep feeding on turnips than the hogs, which are bred on the farm, and perhaps a few draft ewes which had not become fat enough on the aftermath grass in autumn. Occasionally, from want of a good market, or from want of condition, dinmotts (924) are retained to be fed on turnips; and, when this happens, their disposal is subjected to the same considerations as that of the hogs.

3587. When dinmotts or wethers (925) are seen in quantity feeding on turnips, they have been purchased for the purpose, and are in technical language called a *flying stock*; and this is the practice followed by farmers in most arable districts at a distance from large towns, in following which they become dealers of sheep, and are subject to the fluctuations of the markets for profit or loss.

3588. Fat sheep are purchased from farmers both by *dealers* and *butchers*. Dealers buy from farmers in wholesale, and sell to butchers in retail; so they constitute a sort of middlemen; but, unlike most middlemen, their avocation is fully as useful to both parties as to themselves, inasmuch as they purchase at once the whole disposable stock of the farmer, and assorting it, they present it in the most suitable form at the markets which the different classes of their customers, the butchers, are in the habit of frequenting. They buy at fairs, or on the farmer's own premises. In the former case they pay ready money, and lift the stock immediately; in the latter, they pay at the time the stock is lifted by agreement. Dealers chiefly buy at the country fairs, where they have ample choice, and only purchase on the farmer's premises when stock happens to be scarce, and prices likely to advance.

Butchers purchase chiefly in the market towns in which they reside, though they also attend fairs, and pick up a few fat lots which will not bear the long journeys of the dealers; in which case they pay ready money and lift immediately, as dealers do. But when they purchase on the farmer's premises, they usually lift so many at a time, according to agreement, and pay only for what they lift. Every farmer should avoid this practice, as every time the butcher comes for a lot, the sheep have to be gathered, and the whole handled, that he may take away only those which suit his present purpose; and in the commotion thus made, probably every week, the whole stock are disturbed by the shouting of men and the barking of dogs, amongst which the butcher and his dog are not the least noisy or least active. Besides meeting purchasers at home, farmers take their stock to fairs and market-towns; and at fairs they meet both sorts of purchasers, while, in the market towns, the butchers rule paramount. When a dealer purchases on the farmer's premises, he lifts his lot at any time of day that best suits his own arrangements. He begins to lift the first lot in the more distant part of the country, and, proceeding on the road in the direction of their destination, he lifts lot after lot, until the whole are gathered to the amount of many hundreds. In this way he may lift a lot in the forenoon on one farm, and another in the afternoon on another, which is a much more satisfactory way for the farmer to have his stock lifted than the one the butcher chooses to adopt.

3589. The many casualties attending sheep sent to market, should cause the farmer to consider the case well before he undertakes to send them there at his own risk. The expenses of the journey will cost at least 1s. a-head, and their jaded appearance in the market, especially if the sheep have been overtaken by bad weather, may lower their price 2s. or 3s. a-head more; and, besides, the fees of the market have to be paid. But if he cannot dispose of them at home, which sometimes happens, he has no alternative but to send them to market on his own account.

3590. On determining to send them to market, the sheep require to be selected

for the purpose, and divided into equal lots, and each lot marked in a particular manner. The sheep selected for market are the best conditioned at the time, to ascertain which it is necessary to handle the whole lot and shed the fattest from the rest, and this is best done about mid-day, before the sheep feed again in the afternoon.

3591. The sheep should also be marked with *keil*, or *ruddle*, as it is called in England—the ochry-red ironstone of mineralogists, which occurs in abundance near Platte in Bohemia.* The keil-mark is put on the wool and on any part of the body you choose, the purpose being to identify your own sheep in case of being lost in the fair. The parts usually chosen for marking Leicester sheep are on the wool at the top of the shoulder, back, rump, far and near ribs. The mark is made in this way:—Prepare the keil by wetting it and rubbing the part to be used upon a stone. Take hold of a small tuft of wool at any of the above parts with the right hand fingers, and seize it with the left hand with the palm upwards, between the fore and middle fingers, and colour the wool in the palm of the hand with the prepared keil. Short-woolled sheep are usually marked on the head, neck, face, and rump, or with a bar across the shoulders, and generally too much keil is put upon them. The lots are keiled in scores and half-scores, in large or small lots, according to the value of the sheep, and the character of the market.

3592. The selected ones are put into a field by themselves, where they remain until the time appointed them to start arrive. If there be rough pasture to give them, they should be put upon it, to get quit of some of the turnips in them. If there be no such pasture, a few cut turnips on a lea-field will answer. Here all their hoofs should be carefully examined, and the loose horny skin removed, but the *firm* portion of the horn should not be touched. Every clotted piece of wool should also be removed with the shears.

3593. Being thus prepared, the sheep should have food early in the morning, and

be started on their journey about mid-day in winter, and in the afternoon in summer. They should not begin their journey when too full or too hungry. When too full, they will purge on the road, and when too hungry, they will lose strength at once. Let them walk gently away; and, as the road is new to them, they will go too fast at first, to prevent which the drover should go before them, and let his dog bring up the rear. In a short time they will assume the proper speed, about one mile in the hour. Should the road they travel be a green one, the sheep will proceed nibbling their way onwards at the grass, along both sides; but if a turnpike, especially a narrow one, the drover will require to exert all his attention in case of meeting and of being passed by every class of vehicles, to avoid injury to his charge. In this part of their business drovers generally make too much ado, both themselves and their dogs; and the consequence is, that the sheep are driven from side to side of the road more than is necessary. On meeting a carriage, the drover should go forward, instead of sending his dog, and point off, with his stick, the leading sheep to the nearest side of the road, and the rest will follow as a matter of course, while the dog should walk behind the flock, and bring up the stragglers. Open gates into fields are sources of great annoyance to drovers, the stock invariably making endeavours to go through them. On observing an open gate before, the drover should send his dog behind him over the fence, to be ready to meet the sheep in the gateway. When the sheep incline to rest, let them lie down. Before nightfall the drover should inquire of lodging for them for the night. Upon drove-roads, farms will be found at stated distances, with food and lodging for the drover and his flock at a moderate charge. In winter it is requisite to put them into a grass-field, and supply them with a few turnips or a little hay. If turnips or hay are laid down near the gate of the field they occupy, the sheep will be ready to take the road in the morning; but, before lodging them for the night, the drover should ascertain whether the road is infested with stray dogs, which, if it be, the sheep should be taken to the safest spot in the field and watched all night.

* Jameson's *Mineralogy*, vol. iii. p. 245.

Many dogs that live in the neighbourhood of drove-roads, and particularly village dogs, are in the habit of looking out for sheep to worry, at some distance from their homes. Short of sitting up all night, the principal precaution that can be used under an apprehension such as this is, for the drover to go frequently through the flock with a light, be late in retiring to rest, and up again early in the morning. The apprehension regarding dogs is not solely on account of the loss sustained by the worrying, but when sheep have been disturbed by dogs, they will not settle quietly again upon that journey. The first day's journey should be a short one, not exceeding 4 or 5 miles. Allowing 8 miles a-day for a winter-day's travel, and 10 miles in summer, and knowing the distance of the market by the destined route, the sheep should start in good time, allowance being made for unforeseen delays, that one whole day's rest may be secured to the stock near the market.

3594. The *farmers' drover* may either be his own shepherd, or a professional drover hired for the occasion. The flock knowing the shepherd, he makes the best drover, if he can be spared as long from home. A hired drover gets 2s. 6d. a-day of wages, besides travelling expenses, and he is intrusted with cash to pay the dues incidental to the road and markets, such as tolls, food, ferries, and market custom. A drover of sheep should always be provided with a dog, as the numbers and nimbleness of sheep render it impossible for one man to guide a capricious flock along a road subject to many casualties; not a young dog, which is sure to work and bark with a great deal more zeal than judgment, much to the annoyance of the sheep, but a knowing, cautious tyke. The drover should have a walking-stick, a useful instrument at times in turning a sheep disposed to break away from the rest. A shepherd's plaid he will find to afford comfortable protection to his body from cold and wet, while the mode in which it is usually worn leaves the limbs free for motion. He should carry provision with him, such as bread, meat, cheese, or butter, that he may take luncheon or dinner quietly beside his flock while resting in a sequestered part of the road, and slake his thirst in the first brook or spring he finds, or purchase a bottle of ale at a roadside

ale-house. Though exposed all day to the air, and even feel cold, he should avoid drinking spirits, which only produce temporary warmth, and for a long time after superinduce chilliness and languor. Much rather drink ale or porter during the day, and reserve the allowance of spirits he gives himself until the evening, when he can enjoy a tumbler of warm toddy beside a comfortable fire, before retiring to rest for the night. The injunction to refrain from spirits during the day will sound odd to the ear of a Highland drover; but though a dram may do him good in his own mountain-air, and while taking *active* exercise, it does not follow that it will do him as much good on a drove-road in the low country, when walking at a very slow pace, in wet or dry weather. I believe raw spirits do more harm than good to all drovers who indulge in them. He should also have a good knife, by which to remove any portion of horn that may seem to annoy a sheep in its walk; and also a small bottle of a mixture of tobacco-liquor and spirit of tar, with some cloth and twine, to enable him to smear and bandage a sheep's foot, so as it may endure the journey. He should be able to draw a little blood from a sheep in case of sickness. Should a sheep fail on the road, he should be able to dispose of it to the best advantage; or becoming ill, he should be able to judge whether a drink of gruel or a handful of common salt in warm water may not recover it so as to proceed; but rather than a lame or jaded sheep should spoil the appearance of the flock, it should be disposed of before the flock is presented in the market.

3595. Railroads now afford easy means of transit for sheep to markets, to all places, and when the distance to market is considerable, and the sheep valuable, such a mode of conveyance ought to be preferred to driving them on the road. The advantages of railroad transit are, that the sheep need not leave home on a journey so soon by perhaps many days, and, being a short number of hours on the journey, they feel, at its end, neither jaded nor hungry, and will, therefore, enter the market in much finer condition than off a long journey on foot. The shepherd should accompany the sheep in the train, and have them conducted to the market at the proper hour. The cost

of conveying sheep by railroad is that of the truck, which contains a larger or smaller number, according to the size of the sheep. The charge of the truck is by the mile, and the longer the distance the less is the charge by the mile.

3596. Under every circumstance, when you have determined on sending your sheep to a market-town, it is the best plan, after the journey, to intrust them to a salesman, rather than stand in the market with them yourself, as you cannot know the character of the butchers so well as he does, nor can you know what class of purchasers your lot may best suit. The convenience attending the employment of a salesman is now generally felt, as it not only saves the personal annoyance of attending a market, but your money is remitted to you through a bank in the course of the day. The only precaution requisite in the matter is to become acquainted with a salesman of judgment, for as to honesty, if he possess not *that*, he cannot show his face in any market. In attending country fairs, where are no salesmen, you must dispose of your stock yourself. Before attending the fair, you should make up your mind what to ask for the stock, in accordance with the current market prices; but, notwithstanding these, you may have to take more or less cash than you anticipated, as the actual state of the market is regulated by the quality and quantity of the stock in it, and by the paucity or numbers of purchasers who may appear. After your sheep are placed you should inquire of friends of the state of prices before you sell, and on doing this you may find the market in a most perplexing state from various causes. Thus, there may be too many sheep for the buyers, when the market will be dull, and remain so all day. Or the stock may be scanty for the buyers, when a briskness may start in the morning and continue until the whole stock are sold off. Or there may be briskness in the morning, the buyers purchasing—dullness at mid-day, buyers declining—and briskness again in the afternoon, buyers becoming eager. Or there may be excessive dullness in the morning, occasioned by the buyers lying off and beating down prices, and, finding they cannot succeed, buy briskly all afternoon. Or there may be dullness in the

morning, arising from the dealers finding the condition of the stock below their expectation. The market is never better for the farmer than when it begins brisk early in the morning, and the stock are all sold off early. These are the vicissitudes of a market; they are interesting, demand attention, and are worthy of examination. You will frequently observe a trifling circumstance give a decided tone to a market. A dealer, for instance, who generally buys largely, and who has bought for many years in that particular fair, will make the prices of the day by his purchases; so that other people, particularly sellers, observing the prices given by him, will sell briskly and with confidence. There is no use, at any time, of asking a much higher price than the intrinsic value of your stock, or than you will willingly take; for, although your stock may be in particularly fine condition, and of good quality, and therefore worth more than the *average* price of the market, still their value must conform to the *rate* of the market, be it high or low, and it is not in your power to control it, though, should prices dissatisfy you, you have it in your power to take your stock home again. There is a common saying applicable to all public markets, and is now received as a maxim, because indicating the truth, that "the first offer is the best"—that is, the first offer from a sincere buyer, for there are people to be found in all markets who, having no serious intention of buying at market price, make a point of offering considerably below it, with the view of catching a bargain from a greenhorn, or from one tired of standing longer in the fair, and they sometimes succeed in their tactics; but such people are easily discovered, and cannot *deceive* any but inexperienced sellers.

3597. There are certain *rules* which, by tacit consent, govern the principles upon which all public markets of stock are conducted, and they are few and simple. A *custom* is payable for all stock presented at fairs, exigible by the lord of the manor, or by other recognised authority. After entering the field, your stock can take up any unoccupied position you choose, appointed for the particular kind of stock you have to show. No one, on pretence of purchasing, has a right to in-

terfere with a lot which is under inspection by another party. Neither have you any right to show your lot to more than one party at a time, unless both parties consent to it. When a bargain is made, there is no necessity for striking hands, or exchanging money, as an earnest of it. When a bargain is finished, a time may be stipulated by the purchaser for lifting the stock; and until they are delivered to him, or his accredited agents, they continue at the risk of the seller. When counted over before the purchaser, the price becomes immediately due. When the money is paid, there is no obligation on the seller to give a discount off the price, or a *luck-penny*, as it is termed; but purchasers, sometimes to humour the whim of the seller, offer the price demanded, on condition of getting back a certain sum, to bring the price to their own ideas. Sometimes, when parties cannot agree as to price, the offerer proposes to abide by the decision of a third party, but in doing this, you virtually relinquish the power to sell your own stock. Sometimes bills, and bank-post-bills, are tendered by dealers in part or entire payment of their purchases; but it is in your power to refuse any form of cash but the legal tenders of the country, such as Bank of England notes, or gold, or silver. If a bill of exchange or promissory note is proffered instead of ready money, you are quite entitled to refuse the bargain; for the usage of trade in a fair implies the condition of ready money,* or you may demand a higher price to cover the risk of the bill being dishonoured. The notes of a bank you know to be good should admit of no question. After the stock are delivered, they are at the risk of the purchaser. Some dealers' *top's-men*, the men who take charge of their master's lots after delivery, demand a gratuity for their trouble, which you are at liberty to refuse. All these rules, in as far as relates to money and the delivery of stock, apply to the stock purchased by dealers on your own farm. When you *purchase* stock at a fair, people will be found on the ground willing to render your drover assistance in taking them out of it, and of setting them fairly on the road. Such people are useful on the occasion, as it may happen, especially in the case of sheep, that one or more may

break away from their own flock, and mix with another, when there is not only difficulty in shedding them out, but those into whose lot yours have strayed, may show unwillingness to disturb their stock for the sake of rectifying your blunder, though it is in your power to follow your stray stock and claim it anywhere.

3598. Steam vessels carry live stock to the Smithfield market, in London, in large numbers every year; and although stock cannot be carried by vessels so quickly as on railroads, and are subjected, besides, to the effects of storm in a sea voyage, they suffer much less deterioration in them than by travelling a long journey on foot. It has been ascertained that a journey of 400 miles on land causes a loss of 6 stones out of 50 stones, or 12 per cent; whereas the loss by steam is only 2 stones out of the 50; and, besides this great loss itself, the state of the remainder of the flesh is worth 6d. a stone less after land travel. When stock are sent to graze after a journey, they require a month to regain their former state on pasture, whereas the steam-carried are again in the same state at the end of a fortnight. Land travel renders the juices of the meat of fat stock in an unnatural state, while, on being carried by steam, these are not sensibly altered. Heavy and high-conditioned stock, travelling by land long distances, inevitably sink under the attempt, whilst by steam their condition is preserved with comparative ease. The *time* spent on a land journey is of consideration in regard to altering the tone of the stomach of the animals, when a more expeditious mode of travelling would preserve it—and in this respect railroad travelling is eminently superior to any other mode of transit.

3599. When you determine sending stock to London, you should establish a correspondence with a live-stock salesman, who will pay all charges of the journey or voyage, and at market, and remit the balance in course of post. The charges by sea consist of freight, which varies with the distance, commission, hay or grass on board, dues, wharfage, hay or grass on shore, and cost of driving to market. By railroad the cost consists of the value of

* *The Farmer's Lawyer*, p. 143.

the truck, hay or grass at the station, and the cost of driving to market; and there are market dues in both cases. You will never transmit meat to the London market, but you should be well acquainted with all the pieces into which a carcass of beef or mutton is cut up there, that you may know whether your stock is of the description to supply the most valuable pieces of meat; without which knowledge you cannot be certain whether your stock ought to realise the top prices.

3600. When you send sheep to London on your own account, they should be of the following description, to command the best prices; and unless they are so, you had better dispose of them at home. They should be ripe, compact, and of light weight; carrying a large proportion of lean on the back, loins, and shoulders, with a full round leg, and handsome carcass. Such a form, of 14 lb. to 20 lb. a quarter, will readily take, but most so at 16 lb. to 18 lb. the quarter. The nearer in form and quality they approach the Southdowns, the nearer they will command the top price. True-bred Cheviots, and the Black-faced Linton breed, approach near the Southdown, and command a high price. Half-bred sheep, between Leicester tups and the above sorts of Cheviot and Black-faced ewes, afford valuable mutton. The old Black-faced breed are too thin, and are styled *goaty* in Smithfield, and when only half-fat—*half-meated*, as the phrase is—fetch but middling prices, however good the flavour may be. Pure-bred Leicesters are too fat, unless young, and not exceeding 20 lb. a quarter, but above that weight they realise an inferior price, and a difference of 1d. a lb. may constitute all the profit on their export. This last remark applies to every breed of sheep, and shows the expediency of only exporting the best forms, and finest, not fullest condition.

3601. The Edinburgh weekly market on Wednesday contains Black-faced sheep in the highest perfection, and the Cheviot also are very good, and the mutton of both is bought by householders. In Newcastle market on Wednesday are seen Leicester sheep in the highest condition,

and their mutton is bought for the colliers with avidity. The long-established and famed Morpeth market is now transferred to Newcastle, as a consequence of the opening of the Berwick and Newcastle railway. In Smithfield, in London, on Monday, Southdown sheep are to be had in great perfection and beauty, and the mutton they afford finds the most favour in the metropolis.

3602. Fairs, according to Spelman, were first instituted in England by Alfred, in the year 886. They were established generally by order of Gregory VII. in 1078, and were termed *Feria*, at which the monks celebrated the festival of their patron saint: the vast resort of people occasioned a great demand for goods, wares, &c.* Fairs were first held in churchyards on Sunday, and afterwards in the principal street of towns, where a *cross* was erected.

3603. M^Queen estimated in 1836 the permanent stock of sheep in Great Britain at—

19,800,000 of long-wooled, and
28,200,000 of short-wooled.

In all, 48,000,000†

3604. We shall see what proportion of this number of sheep find their way every year to Smithfield—

In 1841	it was	1,435,090
1842	...	1,635,370
1843	...	1,817,360
1844	...	1,804,850
1845	...	1,539,660
1846	...	1,527,220
1847	...	1,505,650
1848	...	1,353,720

Average of the 8 years, 1,579,785

3605. The number 1,353,720, presented in the market in 1848, was divided in each month of the year in the following proportions:—

In January	91,880
February	75,160
March	72,010
April	82,310
May	102,230
June	152,730
July	147,200
August	153,230
September	161,230
October	114,760
November	108,770
December	92,160
	<hr/> 1,353,720

It is necessary to remark that the numbers here stated were the total numbers exhibited, from which ought to be deducted the number which made their reappearance at a future market-day,

* Haydn's *Dictionary of Dates*—art. *Fairs*.

† M^Queen's *Statistics of the British Empire*, p. 21.

and which has been estimated to amount to 100,000 in the course of the year.

3606. The numbers of sheep imported into London from abroad, duty free, in 1848 were as follows in the respective months:—

	Sheep.	Lambs.
In January, . . .	4,608	47
„ February, . . .	1,167	14
„ March, . . .	2,341	...
„ April, . . .	2,479	...
„ May, . . .	4,781	28
„ June, . . .	9,591	74
„ July, . . .	8,705	302
„ August, . . .	14,266	871
„ September, . . .	21,681	...
„ October, . . .	10,669	239
„ November, . . .	13,424	77
„ December, . . .	9,334	111
	<u>103,046</u>	<u>1,763</u>
In 1847, . . .	<u>126,247</u>	<u>4,088*</u>

3607. It might be supposed that the decrease in the number of sheep presented in Smithfield since 1844, was occasioned by the importation of foreign sheep duty free, but this circumstance does not appear to be the cause; for the total number of sheep sold in Smithfield in 1848, was under the average of the 8 years by 122,920, a number considerably more than the importation of foreign sheep into London that year. The very depressed state of trade in 1848 is a more likely cause of the comparative decrease of the number presented to market; and the same cause had evidently a similar effect in decreasing the number of the foreign importation.

3608. The numbers of sheep imported, duty free, into the United Kingdom from the Continent, in 1847 and 1848, were as follows:—

	1847.	1848.
Sheep, . . .	139,371	128,093
Lambs, . . .	3,349	2,177
Total of sheep imported,	<u>142,720</u>	<u>130,270†</u>

ON THE DISPOSAL OF THE FAT CATTLE.

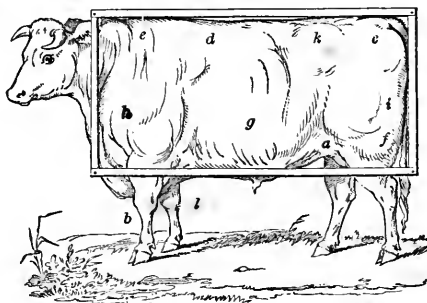
3609. The cattle fed on turnips all winter and spring, are sufficiently fat to be disposed of to the dealer or the butcher by the time all the Swedish turnips are consumed, which may be about the end of May and even the beginning of June. About that time the grass is in a fit state to be pastured by cattle, but the fat cattle are never put on grass, and are disposed of out of the hammels, or from the stalls, to dealers or butchers.

3610. Like sheep, cattle are disposed of to the dealer or butcher either at home or in the public markets in towns, or fairs in the country, and the same rules exist as regards the payment and delivery of cattle as of sheep.

3611. The ox lays on fat in precisely the same manner as the sheep, (3581.)

3612. Prior to disposing of your cattle, either to dealer or butcher, you should estimate their weight and value, and, in *judging* cattle, the procedure is somewhat different from that of sheep, inasmuch as the hair of cattle not hiding the form as wool does that of the sheep, the *eye* is more used than the hand; and, in the case of ripe fed cattle, the eye alone is consulted; but the hand, as well as the eye, is brought into use in judging of *lean* cattle put on to grass or to fatten on turnips. When you look at the *near* side of a *ripe* ox in profile, which is the side always begun with, imagine its body to be inscribed within a frame of wood of the form of a rectangled parallelogram, whose length is horizontal, as in fig. 296; and if

Fig. 296.



THE SIDE VIEW OF A RIPE FAT OX.

the ox is completely filled up in all points, his carcass will occupy the frame about as fully as in the figure; but in most cases deficiencies will exist in various parts,—not that every deficiency will occur in the same animal. The flank *a*, for example, may be shrunk up, and leave a large space above the line of the frame; the brisket *b* may descend much farther down; the rump *c* may be elevated above the line of the back; the middle of the back *d* may be much hollowed below that line; the top of

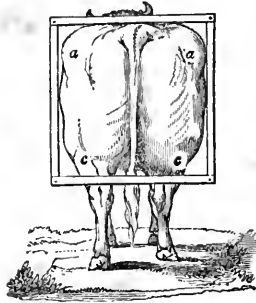
* *Bell's Weekly Messenger*, January 1849.

† *Parliamentary Return*, 26th February 1849.

the shoulder *e* may be elevated above it ; a large space may be left unfilled at the hams *f*.

3613. A similar survey should be made behind the animal: the imaginary frame

Fig. 297.

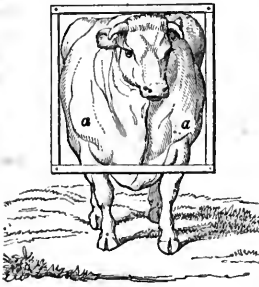


THE HIND VIEW OF A RIPE FAT OX.

inscribing the hind-quarters in this view, being a square, as represented in fig. 297, where the breadth of the hook-bones, *a* to *a*, is carried as far down as the houghs, *cc*; and the closing between the legs is also well filled up.

3614. Then go in front of the ox, and imagine the outline of the body inscribed within the same square frame, as in fig. 298. The shoulders, from *a* to *a*, are nearly of the same breadth as across the hook-bones, *a* to *a*, in fig. 297. Having thus obtained an idea of the outline which a fat

Fig. 298.



THE FRONT VIEW OF A RIPE FAT OX.

ox should have, in all the views

it can be taken, let us attend to the filling up of the areas within the frames.

3615. On looking again at the near-side view, fig. 296, observe whether the ribs *g* are rounded, and nearly fill up the projecting point of the shoulder *h*, and the round *i*. Observe whether the shoulder is flat, somewhat in the same plane as the ribs, or more prominent or hollow; and whether the space behind the shoulder is filled up or hollow. Observe whether the shoulder-point *h* is projecting forward and sharp, or rounded off; and whether the neck, between *e* and *h*, sweeps finely into the shoulder, or is flat and small. Observe whether the muscles at *i* and *f* are full and rounded, or thin and flat; and

whether the hook-bone *k* appears to connect itself easily with the rump *c* on the one hand, and with the ribs *d* on the other, or projects or sinks in. In all these alternatives, the former are the correct, and the latter the objectionable forms, and the correct ones should be arranged in the following manner, to constitute *points* in perfection:

3616. The line from the shoulder *e* to the hook-bone *k*, fig. 296, should be parallel to the back-bone. The line on each side of the ribs *d* to *a*, on the one hand, and to *k* on the other, should not fall in with the line of the back, but be a little nearer, and almost as high as the back-bone, with the ribs falling in a rounded form down the side. The loin above, from *k* to *d*, should be perfectly flat, and on the same level with the back-bone, and drop suddenly down the side, and connect itself with the rounding of the last three ribs. The point of the hook-bone *k* should just be seen to project, and no more; and the space between it and the rump *c* should gradually sweep in a rounded form to the narrower breadth of the pelvis, on each side of the tail head as in fig. 297. The utmost bend of the ribs is at *g*, through which a straight line should touch every point, from the front of the shoulder to the round. The triangular space of the neck comprehended above *h* should gradually taper from the shoulder-point to the head. The line of the back should be straight from *e* to *c*; the tail should drop perpendicularly from *c*; and the belly should sweep in a somewhat level line, not too high at *a* nor drooping at *l*. There are thus three straight lines along the side of a fat ox, one along the back from *e* to *c*, a second through the top of the ribs *g* from *h* to *i*, and the third from the lower part of the shoulder through the flank *a* to the buttock *f*.

3617. Proceeding to behind the ox, fig. 297, the space between the hooks, from *a* to *a*, should be level, but a little rounded off at both sides, and the bone at the top of the tail project a *little* upwards. When the muscles on each side of the rounds, below the hook-bones *a*, are fuller than the hooks, it is no *deformity*, but when no fuller, they are right. The muscles at the buttock, at *c* and *c*, at the lower end of

the small rounds, should sweep gradually towards the hock joints of the legs. The *closing* should be filled to furnish the rounds fully, but freely, for *packed* rounds prevent easy motion of the hind-legs. Sometimes the tail lies in a channel formed between the rounds and buttocks, but this is not commonly the case.

3618. On going to the front view, fig. 298, the shoulder-top should be broad, with its sides naturally rounded, and the muscles below it upon the shoulder-blades at *a* should always project farther than the breadth of the shoulder-top; and in this respect the fore-quarter differs from the hind, where the muscles below the hook-bones do not project beyond them, for if they do, the hook is too narrow. The shoulder points should not be prominent, but rounded off with the muscles of the neck into the brisket, where the front of the neck comes from the head to the breast. The brisket projecting a little forward, falls in a rounded form to the lowest part of the body, and fills out on both sides to the fore-legs. The fore-legs are usually farther apart than the hind, but the hind at times, when the *cod* is large and fat, is even more apart. The fore and hind quarters are more nearly alike in weight, when the fore and hind legs stand equally apart.

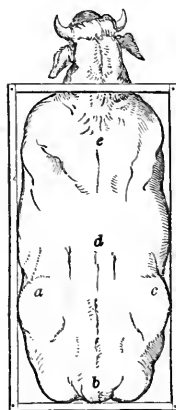
3619. The objectionable deviations from these points are as follows:—In fig. 296, a hollow back at the ribs *d* is bad, showing weakness of the back-bone. A high shoulder at *e* is always attended with a sharpness, having the effect of bringing the shoulders, fig. 298, too close. A long distance between the ribs *d* and hook-bone *k*, fig. 296, makes the loins hollow, gives the ox what is called a *washy* appearance, which is always prone to looseness of the bowels, and washiness is also accompanied with an inordinate breadth of hooks, from *a* to *a*, fig. 297. A sharp projecting hook is always accompanied with flat ribs at *g*, fig. 296, and flat ribs make a hollow side, which bears little flesh, and pushes the viscera into the lower part of the abdomen, causing the belly to droop considerably below the line of the frame. With this conformation, the yellow-coloured, tough, insensible integument of the belly, having a greater weight to bear, becomes thick

and stronger, and the flesh less valuable, and it has also the effect of thinning the flank *a*. Flatness of the rib is also accompanied with a hollowness of the space behind the shoulder, giving to that part of the body a contracted appearance. The sharp shoulder and hollow ribs are accompanied with a projecting shoulder joint *h*, which again causes a thinness of the neck. The ramp-bone at *c* frequently rises upwards, spoiling the straight line of the back; and depriving the rump between *k* and *c* of flesh, where it becomes hollow, deteriorating the value of the most valuable parts of the hind-quarter. A projecting hook-bone *k* also thins the muscles below it, and as far back as the rounds; and this is accompanied with an enlargement of the opening at the closing, fig. 297.

3620. Whenever the shoulder becomes thin and narrow, viewed in front, fig. 298, the shoulder-points are much wider than the shoulder-top; and while this is the case, the brisket below never becomes fat, and then the fore-legs stand too near each other.

3621. A great commendation of a fat ox is a level broad back from rump to shoulder, 'as the whole flesh on that

Fig. 299.



THE VIEW OF THE BACK OF A RIPE FAT OX.

space, seen when viewed from above, fig. 299, is of the most valuable description; where the triangular space included between *a b c* is the rump, the triangular space between *a d c* the loin, and the space between *d* and *e*, deflecting on each side, are the ribs. All the points of a fat ox that have been enumerated can be judged of by the eye alone, and most judges employ no other means; but the assistance derived from the hand is important, and in a pupil cannot be dispensed with.

3622. The first point *handled* is at the tail-head, fig. 296, although the least fat

here is obvious to the eye, and sometimes it attains an enormous size, amounting to deformity. The hook-bone *k* is touched, and should be well covered; but if the bone be easily felt, both the rump between the hook *k* and tail-head *c*, and the loin from the hook *k* to the ribs *d*, may be expected to be hard and deficient of flesh. To the points of the fingers the flesh upon the ribs *g* should feel soft and thick when the ribs are round; but when flat, the flesh feels hard and thin from want of fat. The skin, too, on a rounded rib, feels soft and mobile, and the hair thick set, soft, and mossy, both indicative of a kindly disposition to lay on flesh and fat. The hand, on grasping the flank *a*, finds it thick, when the internal tallow is abundant, as well as the cod fat and large, and, on looking at it from behind, seems to act as a cushion between the hind-legs, to keep them asunder. The palm of the hand passed along the line of the back from the tail-head *c* to the top of the shoulder *e*, points out the hard parts upon it, and when all feels soft and pleasant, the flesh is good. Hollowness behind the shoulder *h* is a very common occurrence; and when it is filled up with flesh and fat, the flesh of the fore-quarter is good. You would scarcely believe the difference of the feel of the flesh betwixt a lean and fat shoulder. A high narrow shoulder *e* is attended with a ridged back-bone, and low-set narrow hooks *k*, a conformation named *razor-back*, always accompanied with a deficiency and hardness of flesh along the back, where the best flesh of a good ox should be. This conformation is always indicative of a slow and obdurate feeder. The shoulder point *h* should be covered, and feel soft like the point of a good hook-bone, and in that state indicates a well-filled neck-vein, which runs from that point to the side of the head. The shoulder point is more often bare and prominent than the hook-bone. When the neck-vein is so firmly filled up as not to allow the points of the fingers to enter into the inside of the shoulder point, it indicates abundance of tallow in the inside; as also does the fulness between the brisket and inside of the fore-legs, and the projection forward of the brisket. When the flesh becomes heavy on the thighs, making a sort of double thigh, the thigh is called *lyary*, and it indicates a tendency in the whole flesh of the ox to grow rather on

the lower than the upper part of the body. These are all the *points* that require *touching when the hand is used*; and in a high-conditioned ox, they are gone over very rapidly.

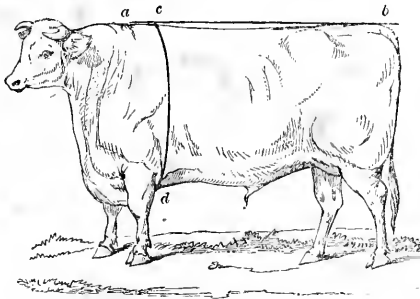
3623. By the former part of these rules you will be enabled to judge by the eye of the points of a fat ox, which ought to be filled up; and, with the assistance of the hand, you will ascertain the degree of perfection which the most valuable points of an ox have attained. On putting those rules in practice as opportunity offers, experience will teach you to estimate the weight of an ox, not its live-weight, but the weight of beef and bones it will yield after deducting the weight of the *offal*, which consists of the skin, head, entrails, and loose tallow. The farmer is entitled to the value of the entire weight of the beef and bones at the current prices; and the profit of the purchaser is confined to the value of the offal: these form the basis of the agreement between him and the farmer. The offals are generally equal to the value of one-fifth of the ox, so that an ox of £25 value in beef and bones, should leave the purchaser £5 for profit, though the offals are worth sometimes below, and sometimes above that value. If the buyer is a good judge of cattle, he knows the exact value of the beef, and will endeavour to make such a bargain with the farmer as will not only leave his profit on the carcass, but cover his expenses of droving and slaughtering. Dealers constantly in practice generally make pretty good bargains for themselves, according to the prices at the time the bargain is made; but their purchases are subject to fluctuation in price, which may fall without an adequate cause, and occasion serious loss; or may rise as causelessly, and leave a handsomer profit than was anticipated—so that the profession of a dealer resolves into a speculation, the issue of which is involved in uncertainty at all times. Dealers formerly made large fortunes, when breeders estimated the value of their own stock with uncertainty, and when dealers invariably purchased in a rising market, but now-a-days few make fortunes, owing to competition, to greater skill in the farmer estimating the real value of his stock, to the great expense incurred in taking cattle to suitable mar-

kets, and to the uncertain incidents of a roving profession.

3624. As long as farmers trusted to their judgment only, when they had few opportunities of exercising it, in estimating the value of stock, dealers had an advantage over them, and the advantage still exists to some extent, but assistance is now afforded farmers to ascertain the nett weight of cattle by *measuring their bulk, or weighing their gravity*. The live-weight of cattle is easily ascertained by placing the ox upon a steelyard, and the nett weight is ascertained by multiplying the live weight with the decimal .605, if the ox is ripe fat, and if not, by .55—that is to say, that the offals and fluids of a lean ox weigh about as much as the beef and bones. An ox should not be weighed immediately after it has taken food, when it will be too heavy, but after it has chewed the cud, and is again ready to eat.

3625. Ascertain the weight by measuring the body of the ox is a more convenient method than weighing; and when the measurement is correctly taken, and the ox of an ordinary size, the result is pretty accurate. Suppose fig. 300 repre-

Fig. 300.



THE MEASURING OF A RIPE FAT OX, TO ASCERTAIN ITS WEIGHT, SINKING THE OFFALS.

sents an ox whose weight is desired to be ascertained by measurement. The mode is, measure with a tape line from the top of the shoulder *a* to the tail-head *b*, which gives the *length*; then measure round the body at *c* to *d*, immediately behind the shoulder, which gives the *girth*; and on consulting any table calculated for the purpose, at the corresponding figures of the length and girth ascertained, the product will give the nett weight. Upon

what principle the rules given in books is founded I cannot say, unless on the assumption that the body of the ox is a hollow cylinder; for a sufficient number of experiments have not yet been instituted to ascertain the exact relation subsisting betwixt the bulk of an ox's body, and the weight of the flesh and bones upon it.

3626. Several such rules exist. Suppose an ox is 5 feet in length and 7 feet in girth. One rule is, Multiply the square of the girth in inches, by the length in inches, and divide the sum by 7344, and the quotient is the weight desired. For example:—

Square the girth in inches,	$\begin{array}{r} \{ 84 \\ 84 \\ \hline 7056 \end{array}$
Multiply by the length in inches,	$\begin{array}{r} 7056 \\ 60 \\ \hline \end{array}$
Divide by 7344	Weight. 423360 (57 st. 8 lb.)

3627. Another rule is, Square the girth in feet, multiply the sum by the length in feet, and multiply the double sum by the decimal .238, and the entire sum is the weight desired. For example:—

Square the girth in feet,	$\begin{array}{r} \{ 7 \\ 7 \\ \hline 49 \end{array}$
Multiply by the length in feet,	$\begin{array}{r} 49 \\ 5 \\ \hline 245 \end{array}$
Multiply by the decimal,	$\begin{array}{r} 245 \\ .238 \\ \hline 58.310 \end{array}$
And the weight is,	58.310 stones.

3628. A third rule is, Multiply half the girth by itself in feet, and the sum by the length in feet, and the double sum gives the weight desired. For example:—

Multiply half the girth by itself in feet,	$\begin{array}{r} \{ 3.5 \\ 3.5 \\ \hline 12.25 \end{array}$
Multiply by the length in feet,	$\begin{array}{r} 12.25 \\ 5 \\ \hline 61.25 \end{array}$
Weight,	61.25 stones.

Here is an average excess of $3\frac{1}{2}$ stones above the first and second rules.

3629. A fourth rule is, Divide the live weight by 8 and multiply the quotient by 5, and the sum gives the nett weight. For example:—

The live weight of $57\frac{1}{2}$ st. dead weight by the rule in (3624,) of .605 is 92 stones.	
Divide by	$\begin{array}{r} 8)92(11\frac{1}{2} \\ 80 \\ \hline 12 \\ 5 \end{array}$
Multiply by	5
And the nett weight is $57\frac{1}{2}$ st.	$\begin{array}{r} 57.5 \end{array}$

3630. A fifth rule is shortly this :—

$$\frac{\text{Girth}^2 \times 5 \text{ lengths}}{21} = \text{Weight.}$$

Square the girth, $\left. \begin{array}{l} 7 \\ 7 \end{array} \right\}$

Multiply by 5 times the length, $\frac{49}{25}$

Divide by 21)1225(58 st. weight.

2631. Thus many rules exist by which the measuring and weighing of cattle may ascertain their nett weights, and many books of tables are found in which those weights are calculated to one's hand. A sliding scale conveniently carried in the pocket, indicating at a glance the weight, with reference to the length and girth of animals, is sold by the philosophical instrument makers.

3632. Lord Farnham's Devon ox, slaughtered in Dublin in 1828, weighed 12 cwt. = 96 st. = 1344 lb. The offals weighed,

	lb.	oz.
Blood,	22	5
... lost,	8	7
Feet,	18	0
Head and tongue,	30	0
Kidneys,	4	0
Hide,	80	0
Heart, liver, and lights,	25	0
Guts and contents,	135	4
Fat,	152	0
Weight lost by evaporation from the carcass,	25	0
	504	0
Live weight,	1344	0
Equal to 60 stones,	840	0

The rule by measurement in (3628) comes nearer the truth than those founded on live weight either in (3624) or (3629).*

3633. After repeated trials by Mr Robert Stephenson, Whitelaw, East Lothian, on a number of oxen of the same weight and age, of the relative proportions of their live and dead weights, the following conclusions were come to—that every 100 lb. of live weight gave of

Butcher meat,	57.7	per cent.
Tallow,	8.0	... .
Hide,	5.5	... .
Entrails and offal,	28.8	... .
	100.0	

3634. Accurate measuring would easily be acquired, and the result would ever be correct, were the form of the ox always perfect, which it very seldom is, the fore and hind quarters being frequently unequal; and the degrees of condition various. The judgment is called into exercise to make allowance for those differences, and the allowance may be made somewhat in this manner:—When the fore-quarter seems heavier than the hind, the line should be extended nearer the head than the exact top of the shoulder *a*, fig. 300; and in like manner, when the hind-quarter is heavier than the fore, the line should be stretched a little beyond the tail-head *b*. In regard to the girth, it is a very common fault in the carcass of an ox to be contracted behind the shoulder; the actual girth of which gives a result below the truth. It is very rare to find the girth filled out beyond its proper form. The tape line must therefore be applied with judgment. The line is most conveniently divided into feet and *tenths*, instead of eighths, because the multiplication by decimals is the easiest. As an illustration of the practical effects of misapplying the tape-line, I may state, that one inch only added to the girth and length, assumed in the above examples, makes an increase in the above weights of upwards of 2 st. The addition of one inch to the length is a mistake easily made when the ox stands with his head down; and a similar error may as easily be made in the girth, when the ox stands with his back raised. Experience alone can give proficiency in measuring cattle. I knew a steward in Berwickshire who so successfully measured cattle, and had so many opportunities of verifying his measurements, that the measured weight of an ordinary ox, whether fat or half lean, differed only from 1 st. to $\frac{1}{2}$ st. of its real weight.

3635. To an ox from 40 to 70 stones the tables in books apply pretty near, when the measurement is made with judgment; but in weights below and above those figures, the tables are at fault. I have no instances to adduce of error in very small weights, but many in large ones, and shall only adduce one. A short-horn white ox, belonging to Mr Boswell

* *Quarterly Journal of Agriculture*, vol. iv. p. 552.

Irvine of Kingcausie, was exhibited at the Highland and Agricultural Society's Show at Aberdeen in October 1834. Its measurement was 9 feet 3 inches in girth, and 6 feet 2 inches in length. According to Renton's tables, the farmer once of Dykegatehead, in Berwickshire, the weight was 126 st. 9 lb.; to Strachan's 124 st. 2 lb.; to Ainslie's 122 st.; and to Stewart's 117 st. The actual weight of beef yielded by the ox was 136 st. 10 lb., on being slaughtered by Deacon Sparks of Aberdeen, being 10 st. 1 lb. more than the heaviest, and 19 st. 10 lb. more than the lightest weight indicated by the tables. Such deficiencies of weight, at 7s. the stone, incur a loss to the feeder of from £3, 10s. 6d. to £6, 18s. upon a single ox!

3636. The rule for live-weight is also liable to error when applied to oxen of extraordinary weight. Thus the late Lord Kintore's black ox, 7 years off, exhibited on the above occasion at Aberdeen, weighed, alive, 28 cwt., or 224 stones. By the rule of multiplying the live-weight by the decimal .605, the dead weight should have been 135 st. 7 lb.; but when the ox was slaughtered by Mr Rodger, Crown Street, Aberdeen, it weighed 173 st. 4 lb., or 37 st. 11 lb. more than the rule indicated, which, at 7s. the stone, made it worth more by £13, 4s. 6d.! On the other hand, a small spayed heifer, belonging to Mr Boswell Irvine, weighed 88 st. live-weight, which should have yielded, by the rule, 53 st. 3 lb., but it only weighed 49 stones. The rule in (3624) is equally in error when applied to these cases.

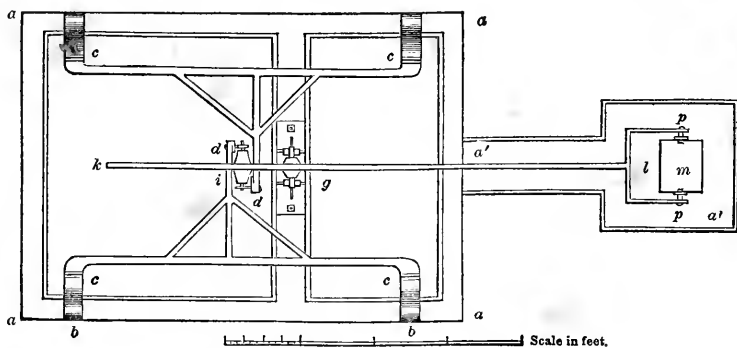
3637. Such discrepancies certainly ren-

der it desirable that means were used for rendering the rules of measurement, as well as of weight, more correct than they are; and I see no way of effecting this end but in collecting data, by instituting experiments in different parts of the country, to measure and ascertain the live-weight of every animal before it is slaughtered, be it ox, sheep, or pig, large or small, for a given period, and to weigh its fore and hind quarters, after it is slaughtered.

3638. *The cart-steelyard or weigh-bridge.*—As I have mentioned the weighing of cattle alive, for the ascertaining of their value as a marketable commodity, and as many occasions occur in farms for weighing heavy weights, it is proper to give a description of such a steelyard as will be useful on a farm. The cart-steelyard is a machine in which a combination of levers are employed to effect, in a commodious way, the weighing of bodies of considerable weight, and which would require the common Roman steelyard of most inconvenient dimensions, or a balance equally cumbrous, besides the inconvenience of a great mass of moveable weight. The combination consists of two double-fulcrum levers of the second order, combined with a single lever of the first order. The relation of the arms of the first are $3\frac{1}{2}$ to 1, and of the second 8 to 1, making the ultimate ratio 28 to 1; so that every cwt. placed upon the platform of the machine is balanced by 4 lb. on the scale-board attached to the second lever.

3639. In describing the construction of this compound steelyard, we have in fig. 301, the ground plan: the bed-frame *a a a a*,

Fig. 301.

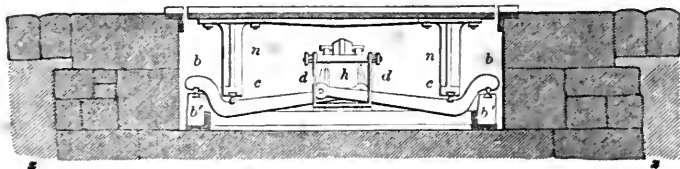


PLAN OF THE CART-STEELYARD.

which is 6 feet in length by 4 feet in breadth, is surrounded by a stand-up flange. This frame is laid in a pit formed of masonry *x x*, figs. 302 and 303, adapted to the size of the frame, and having the

surface of its foundation course laid level, under the surface of the ground, sufficient to bear the sole-frame, and upon which it requires to be solidly bedded. Four blocks *b' b'*, fig. 302, are faced on their

Fig. 302.

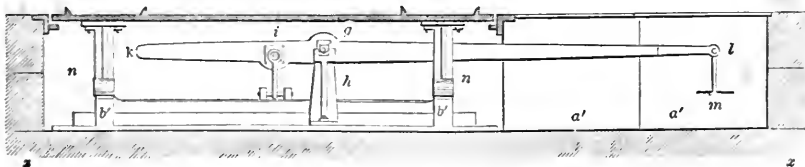


TRANSVERSE SECTION OF THE CART-STEELYARD.

top-surface with a cradle of steel, forming the dead fulcrum of the levers. The two first levers *b c d*, *b' c d*, fig. 301, seen in profile at *b c d*, *b' c d*, fig. 302, are so formed in the horizontal direction as to bring their points of bearing at *b*, *c*, and *d* to the requisite position; and in the vertical direction, to bring the centres *b c d* into one plane. When the levers are duly placed, their ends *d* pass each other, being thus suited to the centres of the second lever. The second lever *k l*, figs. 301 and 303, has its main centres *g* supported upon

the two arms of the standard *h*. From the centre *g* to *i*, and from *g* to *l* is 8 to 1; the extremity *i* to *k* being for the purpose of adjusting the equilibrium of the machine. Upon the two centres *i*, fig. 301, links are appended, which, in their lower bend, receive the centres *d d* of the two first levers, and the extremity *l* is formed into the fork, upon the centres of which, *p p*, the scale-board *m* is suspended. In the chamber *a' a'*, the second lever vibrates. The platform, which is left out in fig. 301, but is seen in profile in figs. 302 and 303,

Fig. 303.



LONGITUDINAL SECTION OF THE CART-STEELYARD.

is a frame with raised ledges, to guide the cart-wheels when being placed upon the platform. Four pendant pillars *n*, fig. 302, attached to the platform, bear equally on the centres *c* of the first levers. If the equilibrium of the levers is not perfect, it is to be adjusted by adding to or taking from the back end of the second lever. Stud's projecting inward, coming under the platform at the wheel-tracks, serve to bear not only the weight of the platform when unloaded, but to receive the shocks of the load when coming upon it, thereby saving much of the tear and wear of the centres.

but this being extremely small, the want of lateral motion does not affect the accuracy of the indications. In those machines having slight lateral motion, the principle of the levers is the same as here described, the chief difference being that the platform is suspended upon links, to accommodate which the pillars *n n* are lengthened downwards, and hooked under the first levers, so as rest upon the links suspended from them.

3640. In this form of weighing-machine, it will be observed that the platform can have no lateral motion, which would be a defect if it had a great range vertically;

3641. The most perfect form of such steelyard I have seen was that exhibited by Mr Craig, Liverpool, and manufactured by Redpath, Brown, and Co. Edinburgh, at the general show of the Highland and Agricultural Society of Edinburgh, in August 1848. This machine is adapted to

the weighing of cattle, as well as every other live or dead stock, whether of large or small bulk and weight. It is constructed on the principle of combined levers, is provided with a platform, the size of which is proportioned to the intended purposes, the platform being suspended on, or appended to, the levers. It is thus of the same principle in construction as the steelyard I have described; but its bearings are so arranged as to weigh any object accurately, no matter on what part of the platform it may be placed. In the machine exhibited, and tested by weighing animals and articles, the platform is 6 feet $3\frac{1}{2}$ inches, and is provided with a movable railing or pen, to insure safety to live animals while being weighed. The price is £22. Other steelyards range in price from £15 to £25.

3642. Whether the fat cattle are disposed of to the dealer or butcher, or are intended to be driven to market by the farmer himself, they should undergo a preparation for the journey. If immediately made to travel on the road from feeding on turnips, when the bowels are full of undigested vegetable matter, a scouring ensues which soon renders them unfit to pursue their journey; and the complaint is the more likely to be brought on from the great propensity which cattle evince to take violent exercise on feeling themselves at liberty, after a long confinement in the house. They become *light-headed* in leaving even the hamlet, and remarkably so on being brought out of a byre, when their clumsy antics would be highly amusing, were it not for the apprehension that they will hurt themselves against every object, which they seem not to see before them, their visual organs being evidently at fault at the time. I remember seeing a dodged Angus stot let out of a byre running so recklessly about, that at length he came at full speed with his head against the wall of the stading, and was instantly felled to the ground. Before any one, however, could run to his assistance, he sprang to his feet and made off again at full speed, with his head high up, and tail on end, as if feeling proud of having accomplished a feat which none of the others dared to do. With distended nostrils and heaving flanks, he seemed painfully excited; but on being brought again into

the byre, he soon calmed down and became exhausted. On being let out for the first time, cattle should be put a while into a large court, or in a road well fenced with enclosures, and guarded by men. Two or three times of such exercise will make them quiet; and in the mean time, to lighten the weight of their carcass, they should have hay for the largest proportion of their food. All these precautions are absolutely requisite for cattle which have been fed bound for months to the stake, otherwise accidents will befall them on the road. Even when retained at home, serious accidents sometimes overtake cattle let out of a byre, such as the breaking of a horn, casting of a hoof, spraining a tendon, bruising ribs, and heating the whole body suddenly and violently—and every such ill-luck befalling an animal, affects its value in the market to a sensible degree.

3643. Having been thus prepared for the road, the *drover*—who may be your own shepherd, or a hired professional drover, on the supposition that you are to take your cattle to the market—takes them along the road very slowly for the first two days, not exceeding 7 or 8 miles a-day. At night, in winter, they should be put into an open court, and supplied with hay and water, and a very few turnips; for if the turnips are suddenly withdrawn from them, their bellies will *cling* or shrink up—a state very much against the appearance of every animal in a market, as it may be the effect of disease. In summer, a grass park suits them best to feed and rest in. After the first two days, they proceed faster, say 12 or 13 miles a-day, if very fat, and 15, if moderately so. When the journey is long, and the cattle become faint in travelling, they should get corn to support them. In frosty weather, when the roads are hard, cattle are apt to become *shoulder-shaken*, which is one effect of founder; and if sleet fall during the day, and become frozen upon them at night, they will be chilled so as to refuse food altogether, and shrink rapidly in bulk. I had a lot of 12 Angus oxen so affected, on their road to Glasgow, when overtaken by an unexpected storm as late in the season as May, that I scarcely recognised them in the market, and their value was deterio-

rated to the amount of £3 a-head. Cattle should arrive the day before in the neighbourhood of a distant market, and be supplied with good turnips and hay, or grass, to make them look fresh and to fill up their flanks again; but if the market is only a short distance, they can travel to it from early morning.

3644. In driving cattle, the drover should have *no dog*, which will only annoy them. He should walk either before or behind the drove, as he sees them disposed to proceed too fast, or loiter on the road; and in passing carriages, the leading ox—for one generally assumes a leadership after travelling for a while together—with a little experience, will make way for the rest. In other respects, their management on the road is much the same as that of sheep, though the rate of travelling is quicker. Accommodation will be found at night at stated distances along the road.

3645. On putting oxen into a ferry boat, the shipping of the first one only is attended with much trouble. A man on each side should take hold of a horn, or of a halter of rope, should the ox be hornless, and other two men, one on each side, should push him forward from behind with a piece of rope held between them for a breeching, and the men should simultaneously conduct him along the plank into the boat. This arrangement of the men should be adopted at once, and not after it had been found impossible to induce the ox to go aboard of himself, or by dint of twisting his tail, the irritation occasioned by which will cause every subsequent plan difficult of execution. If the boat have low gunwales, one man should remain beside the ox until one or two more cattle follow their companion, which they will most readily do. In neglecting to guard the first ox in small ferry-boats, I have seen it leap into the water, and it is then difficult to prevent the rest doing the same from the jetty.

3646. Whatever time a lot of cattle may take to walk to a market, they should never be *overdriven*. The flesh of overdriven cattle, when slaughtered, never becomes firm, and the tallow has a soft, melted appearance. Much diversity exists in managing cattle on the road by drovers.

Some like to proceed on the road quietly, slowly, but surely, and to take them into the market in a placid, cool state. Others drive them smartly along for some distance, and then rest them to cool a while, when they will probably become chilled, and have a staring coat when they enter the market. Whilst others like to enter the market with the cattle in an excited state, imagining that they look gay; but distended nostrils, loose bowels, and reeking sides, the ordinary concomitants of excitement, are no recommendations to a purchaser. Good judges are chary of purchasing cattle in a heated state, as they do not know how long they have been so, and to cover the risk, will offer a lower price for them than in a cool state. Some drovers have the habit of thumping the hindmost ox, whichever it may be, with his stick, while on the road. This is a reprehensible practice, as the flesh, where thumped, will bear a red mark after the animal has been slaughtered, named a *blood-burn*. The flesh so affected will not take the salt, and is apt to putrefy. A touch upon the shank, or any tendonous part, when correction is necessary, is all that is required; but the voice, in most cases, will answer the end.

3647. A few large oxen look best together in a market, on a position rather above the eye of the spectator. When a large lot is nearly alike in size and appearance, they look best and *level*, on a flat piece of ground. Very large fat oxen never look better than on the same level with the spectator. To look in the best state, an ox should hold his head in a line with his body, have lively ears, clear eye, dewy nose, a well-licked hide, and stand firm on all his feet. These are invariable symptoms of high health and good condition. Whenever you see an ox shifting his standing from one foot to another, he is *foot-sore*, and has been far driven. When you observe him hanging his head, and his eyes watering, he feels ill inwardly. When his coat stares, he has been overheated some time, and has become subsequently *chilled*. These latter symptoms will be much aggravated in cattle that have been fed tied to the stake. You may at once discover whether cattle have been fed at the stake, by observing a fretted and callous mark occasioned by the rubbing of

the baikie or seal, figs. 75 and 76, on the top of the neck, immediately behind the ears; by the hoofs being overgrown at the points; by marks of dung and of much resting, upon the outside of the hams; and also very frequently by the remains of lice upon the tail-head and the top of the shoulder, their scurf remaining, or the hair shorn bare from those parts.

3648. Steam conveyance by sea and land is now so common from all parts of the country, and from sea-ports, that fat cattle are not now travelled on foot to markets at great distances, as was wont to be the case some years ago; still it is well for you to be made acquainted with the best method of driving cattle on the road, since most parts of the country at which cattle are fattened are situate at considerable distances both from railway stations and shipping harbours. Fat cattle must still be driven to local fairs from short distances, and in those short journeys they require to be as well guided as on long ones.

3649. The *customs* relating to the purchase and sale of cattle in fairs, and town markets, are precisely the same as those connected with the disposal of sheep, (3597.)

3650. On consigning fat cattle on your own account to London, either by steamboat or railroad, it is necessary beforehand to establish a correspondence with a respectable salesman. I say with a salesman of established character, for that class of persons having the monopoly of the sale of stock at Smithfield, some of them effect sales for their customers in a questionable manner. It has been alleged, for example, that "each salesman receives consignments of stock from several graziers, and it frequently happens that when a sale is effected, say of 100 cattle or sheep, composed of perhaps 10 from one grazier, 20 from another, 30 from another, and so on; they, of course, vary in quality and size; the 10 or 20 being perhaps far superior to those with which they are sold; but it often happens that one general average price is fixed for the whole: thus it occurs that the judgment of the salesman

is the only criterion of value, and the returns of the prices to the respective graziers must depend entirely on his discretion; the apportioning of the money taking place in the money taker's office." Thus your good cattle may be slumped in price with the inferior ones of another person. "Again, we will suppose a case of consignment of 100 cattle or sheep by one person: these may be sold in one lot at an average price; but in order to satisfy his principal, it is not unusual for the salesman to render a fictitious account, showing that the sale was effected by tens or twenties to different persons, and at prices varying, but making up the amount for which they were actually sold. The reason given for this proceeding is, that the salesman wishes to gain a name for making exertion to obtain the best prices, which might be questioned if the animals were returned as sold in one lot."*

3651. Besides this unfair mode of sale, the injuries probably to be sustained by the cattle or sheep you may consign to a salesman, on their way through the streets to Smithfield, are at times to a serious amount. "The loss to the grazier," says a writer, "is in the difference in value of his sheep or cattle, when they arrive in the neighbourhood of the metropolis, and when offered for sale in Smithfield after intense suffering from hard blows, driving over the stones, from hunger, thirst, fright, and the compressed state in which they are constrained to be packed; the sheep and beasts the whole time, from their raised temperature, clouding the atmosphere of Smithfield with dense exhalations from their bodies. The London butcher, carrying on a respectable trade, will at all times, when he enters the market, reject such cattle or sheep as are what is termed in a *mess*; that is, depressed, after excitation by being overlaid or overdriven, or such as have been more than usually troublesome in getting into the market, and, consequently, will be in a more worried and exhausted condition. It is to be observed, that all animals brought into Smithfield, especially on the Monday's market-day, are more or less in the condition above described." This was the case when an inquiry was made into the

* *Inquiry into the State of Smithfield Cattle Market in 1848*, p. 6.

state of the market in 1828; and the inquiry instituted in 1847, by a committee of the House of Commons, presents no improvement of the picture, as may be seen by the evidence of Mr Walter Anderson, Oakley, a grazier near Bedford, when, in answer to the question put to him, "In what way were cattle ill treated?" he answered, "I have witnessed in Smithfield, on four different occasions, when I have gone there to see my beasts, which were of very good quality, they have been put into ring-droves, where they have been crammed in so thick that I have not been able to see my animals for two hours; and when they have been brought out, they were so disfigured with mud, and bleeding, that I should not have known them, unless the mark was pointed out to me."*

3652. The blows and bruises sustained by the cattle and sheep materially affect their market value, and the state of their flesh as an article of food. "A calculation has been made," says another and earlier writer, "that 512,000 serious and extensive œdematous bruises are, in the course of one year, discovered on cattle after they are slaughtered. The pain these bruises must occasion to the cattle, and the loss to the butcher or the public, is exclusive of those parts of the animal which suffer most from the conduct of the drovers, namely, the head, especially the nasal organs, and concussion of the brain by blows on the horns, besides the more acute suffering from blows on the locks." The beef consumed in London, in 1836, he states, amounted to $9\frac{1}{2}$ millions of stones, which, at 6s. a stone, gives a total value of £2,850,000; and if its deterioration is taken only at half-a-farthing per pound, the annual loss sustained by the bruises of cattle alone, will amount to £69,270, 16s.† This was in 1828, and from the increase in the number of cattle since that period, and the consequent curtailment of space allotted to each, the loss sustained by bruises was calculated, in 1848, to amount to £100,000.

3653. Cattle and sheep are not free from serious accidents on board steam-vessels in stormy weather. The cattle break

loose from their fastenings, and, in knocking against each other and the sides of the vessel, become bruised to a considerable degree; and, in some instances, have been thrown overboard to secure the safety of the vessel. If such confusion is bad below decks it is much worse upon deck, where the cattle interfere with the working of the ship. In the event of such a risk, it is much safer to transmit them in the trucks of a railway than in the holds or decks of steam-vessels.

3654. The charge for conveying cattle to London by the steamboat and railway increases, of course, with the distance, but less in proportion for the longer distance. The charges are too costly; but, to view the matter in its proper light, the cost should be compared with the loss of condition incurred by sending fat stock on foot to the same distance. Mr D. Martin of Wainfleet, in Leicestershire, ascertained the difference by experiment. He walked 5 sheep to London, which weighed 858 lbs. live-weight, and, on being killed there, their carcasses weighed 435 lb., and the loose fat 60 lb.; whereas 5 sheep of the same weight, killed at home, yielded 489 lb. of mutton and $74\frac{1}{2}$ lb. of loose fat, the difference $68\frac{1}{2}$ lb. in favour of those not travelled, at 6d. the lb., gives a sum of 34s. 3d., which would have paid the cost of a very long journey by the railway.‡

3655. It has long been my opinion that cattle and sheep conveyed by railway ought to pay by weight, as goods do, and not by bulk as gauged in a truck. The present plan has the effect of overcrowding fat stock in the truck, and of discouraging the sending of lean stock by rail; for lean cattle occupy more space in proportion to their value than fat, and their lower value is, besides, less able to pay the higher fare. It would not be difficult for the station master, or the servants at the station, to ascertain the live weight of stock by weighing one animal of every equal lot on the weighing-machine, always at the station; and such practice, for a short time, would enable them to determine the weight by the eye. Were farmers to

* *Inquiry into the State of Smithfield Cattle Market in 1848*, p. 19.

† *The Question of the Smithfield Market fully considered*, p. 21 and 24.

‡ *The Railway Bell*, for February 1847.

press this change on the railway authorities, and show, by a practical trial, the ease with which it might be effected, it would no doubt be adopted on the principle of fair dealing. Stock gives less trouble than goods to railway servants, in the putting in and the taking out of the trucks, and they occupy no warehouse room; and therefore, if they paid the same charge as goods, they would be more profitable traffic to the company.

3656. The importation of horned cattle from Ireland and Scotland into England, was prohibited by a law, 16 Charles II. 1663; but the export of cattle from Ireland now forms a vast and beneficial branch of the Irish trade with the sister country. From the inferior port of Waterford alone, the value of imported cattle and provisions amounted, in 1841, to nearly half a million sterling.* Now all live animals are imported from all quarters of the globe into Britain free of duty.

3657. The numbers of cattle presented in each month of 1848, for sale in Smithfield market, London, were as follows:—

	N. Districts.	E. Districts.	W. and Midland Districts.	Other parts of England with Ireland.	Scotland.
In January,	4,150	2,200	2,000	2,900	790
... February,	3,000	4,200	1,800	2,700	610
... March,	2,000	4,500	2,300	1,600	850
... April,	1,000	5,400	2,500	1,350	840
... May,	500	5,900	2,800	2,100	2,500
... June, . . . .	...	6,300	3,000	1,900	3,180
... July,	900	5,000	3,800	2,250	790
... August,	3,000	8,000	1,480	1,960	960
... September,	5,000	2,000	2,600	3,450	572
... October,	7,200	800	4,550	1,810	910
... November,	6,300	1,500	2,600	3,350	400
... December,	6,000	2,500	4,600	3,900	290
	<u>39,650</u>	<u>48,300</u>	<u>32,830</u>	<u>29,270</u>	<u>12,752</u>
In 1847,	<u>47,870</u>	<u>48,700</u>	<u>27,800</u>	<u>26,150</u>	<u>8,725</u>

A few deductions may be drawn from the numbers of this statement. From the northern districts the chief supplies are in the beginning and end of the year, indicating there the prevalence of arable husbandry, and fattening with turnips, and little grazing. The same remark applies to other parts of England with Ireland; but, from these districts, the supply is more uniform than from the northern districts. From the eastern districts the supply is scanty in winter, the fattening on turnips being evidently limited, while the grazing in summer is carried on to a large extent. The supply from the western and midland districts is more regular throughout the year than from any other district, while it rather increases in winter, indicating fattening for a short time on turnips from the grass in autumn. The grazing beasts are largely supplied from the north of Scotland in the early summer months. On comparing the numbers of 1848 with 1847, we find a falling off of the Short-horns from the northern districts,

	Oxen.	Cows.	Calves.
In January,	15,589	480	770
... February,	15,404	570	859
... March,	15,407	601	1,122
... April,	15,322	577	1,375
... May,	16,541	491	2,087
... June,	17,452	509	3,846
... July,	16,878	495	4,033
... August,	17,975	497	3,840
... September,	21,714	421	2,707
... October,	20,177	487	2,200
... November,	19,700	544	1,483
... December,	19,855	620	1,263
	<u>212,014</u>	<u>6,292</u>	<u>25,585</u>

Total number of cattle, . . . 243,891

In regard to these numbers, it should be borne in mind that they represent the total numbers exhibited in each month; but a deduction should be made for the cattle turned out unsold in one market day, and which make their appearance in another. It has been estimated that about 25,000 cattle reappear in the course of a year.

3658. It is interesting to observe the proportions in which the oxen from the different districts of the kingdom found their way to London in the different months of the year: in 1847 and 1848:—

	N. Districts.	E. Districts.	W. and Midland Districts.	Other parts of England with Ireland.	Scotland.
In January,	4,150	2,200	2,000	2,900	790
... February,	3,000	4,200	1,800	2,700	610
... March,	2,000	4,500	2,300	1,600	850
... April,	1,000	5,400	2,500	1,350	840
... May,	500	5,900	2,800	2,100	2,500
... June, . . . .	...	6,300	3,000	1,900	3,180
... July,	900	5,000	3,800	2,250	790
... August,	3,000	8,000	1,480	1,960	960
... September,	5,000	2,000	2,600	3,450	572
... October,	7,200	800	4,550	1,810	910
... November,	6,300	1,500	2,600	3,350	400
... December,	6,000	2,500	4,600	3,900	290
	<u>39,650</u>	<u>48,300</u>	<u>32,830</u>	<u>29,270</u>	<u>12,752</u>
In 1847,	<u>47,870</u>	<u>48,700</u>	<u>27,800</u>	<u>26,150</u>	<u>8,725</u>

and an increase of the Devons and Herefords from the western and midland districts, while the supply from the eastern districts is about the same. From Scotland, the increase in 1848 is very marked, owing, no doubt, to the accommodation of direct conveyances on the railways from Scotland to London.

3659. The number of oxen presented at Smithfield for the last 8 years was as follows:—

	Oxen.
In 1841,	194,298
... 1842,	210,723
... 1843,	207,195
... 1844,	216,848
... 1845,	222,822
... 1846,	233,402
... 1847,	216,280
... 1848,	212,014
	<u>1,713,582</u>
Average of the 8 years,	<u>214,197</u>

* Haydn's Dictionary of Dates—art. Cattle.

3660. Mr McQueen, in 1836, estimated the number of cattle in the United Kingdom at 15,400,000, divided thus:—

Bulls, young and old,	500,000
Cows,	7,000,000
Oxen, fat, to kill,	2,000,000
... growing up to fatten,	4,000,000
... used to work,	500,000
... to replace waste,	1,400,000
	<hr/>
	15,400,000

Or thus: Permanent stock,	14,000,000
To replace waste, one-tenth,	1,400,000
	<hr/>
	15,400,000*

3661. The cattle and calves imported duty free, from the Continent into London, in each month of the year 1848, were as follows:—

	Cattle.	Calves.
In January,	720	110
... February,	852	103
... March,	1,146	434
... April,	2,456	466
... May,	2,197	898
... June,	2,044	1,692
... July,	1,666	1,706
... August,	2,526	2,135
... September,	4,301	1,625
... October,	2,962	603
... November,	3,483	669
... December,	2,401	492
	<hr/>	<hr/>
	26,759	11,133
In 1847,	32,968	8,433‡

3662. The total numbers of cattle imported, duty free, into the United Kingdom, in the course of 1847 and 1848, were as follows:—

	1847.	1848.
Oxen and bulls,	27,831	24,591
Cows,	35,480	22,510
Calves,	12,406	15,642
	<hr/>	<hr/>
Total of cattle imported,	75,717	62,743‡

3663. Cows are chiefly imported from Holland, and calves from Holland and Belgium, whilst the oxen mostly come from Holstein. Dutch cows are good. The Dutch and Belgians feed calves well. The pastures of Holstein afford the best oxen of any imported.

3664. At the end of the season of fattening the cattle, it is profitable to hear the conclusions arrived at by so acute and scientific an experimenter and philosopher as M. Boussingault, on the experiments made by Mr Robert Stephenson, Whitelaw, East Lothian, an abstract of which is given from (1342) to (1350.) "In a series of experiments which he undertook," says M. Boussingault, "Mr Robert Stephenson proposed to compare the progress of the increase in weight of oxen upon different alimentary regimens. Starting upon the principle which we have already established—that animals consume a quantity of food in proportion to their weight and size, when they are under the same conditions—he had, of course, to divide his stock into several lots, each made up of animals of as nearly as possible the same weight. Oxen of two years old, brought up on the same farm, and kept in the same manner, were the subjects of experiments. I shall select one experiment, in which the observations were made upon three lots of six beasts each. The live weight of each lot was ascertained before and after the experiment, which was carried on for 119 days, 1. The first lot was put upon white turnips, linseed oilcake, beans, and oats; and, for the last 24 days, each beast had 20 lb. of potatoes every day in addition. 2. The second lot was fed like the first, with this difference, that it had no cake; and that, during the last 24 days, the quantity of potatoes allowed was but 10 lb. a-day. 3. The third lot had no other provender than turnips.

3665. "Here are the weights and nature of the provender consumed by the animals during the 119 days, with a column added, containing the equivalent in hay corresponding to each article consumed:—

PROVENDER.	Lor 1.		Lor 2.		Lor 3.		Equivalent in hay assumed.
	Weight.	Equivalent in hay.	Weight.	Equivalent in hay.	Weight.	Equivalent in hay.	
White turnips,	1,518·0	171·6	1,628·0	184·8	1,122·0	127·0	385
Swedes,	13,336·0	1973·4	13,384·8	1980·0	12,012·0	1777·6	676
Beans,	358·0	1559·8	538·0	1559·0	..	..	23
Oilcake,	389·0	1768·0	..	..	..	..	22
Oats,	173·0	279·0	173·0	279·0	..	..	62
Potatoes,	479·0	151·0	239·8	77·0	..	..	315
Ration expressed in hay,		5,902·8		4079·8		1904·6	
Hay consumed per head per day,		49·7		34·3		160	
Hay per 100 lb. of the live-weight,		4·01		3·03		2·0	

It therefore plainly appears that the lot which had the largest allowance of provender, the food which contained the greatest quantity of azotised principles of flesh, in fact produced the largest amount of dead-weight in a given time; and that the lot which had the shortest allowance in-

creased in the smallest measure, both in flesh and fat—results which might have been readily foreseen.

3666. "It is also apparent, from the table, that, in proportion to the nutritive value of the

* McQueen's *Statistics of the British Empire*, p. 18.

† *Bell's Weekly Messenger*, January 1849.

‡ *Parliamentary Return*, 26th February 1849.

articles consumed by each lot, the increase in carcass-weight was greatest in that which received its allowance in the least bulk. Thus reducing the different rations to a standard forage, we find that in the first lot, which was plentifully supplied, 100 lb. of hay gained 4.2 lb. of increased weight, whilst the same allowance of hay produced 6 lb. in the third lot, which was fed most parsimoniously. The fact is most readily explained; over a certain limit, the more food an animal receives, the smaller is the fraction which is assimilated and turned to use in the body. Breeders have consequently discovered, that it is by no means generally advantageous to push animals beyond a certain point of fatness. The excess of weight which is obtained with the assistance of the quantities of food exaggerated as it were, no longer compensates for the additional expense incurred. This is a circumstance which Mr Stephenson's experiments also illustrate; and, indeed, they led him to the conclusion which has just been stated.

3667. "Judging by the market price of the several articles of provender employed by this distinguished breeder, the first lot appears to be the one the fattening of which turned out the least advantageously; whilst each pound weight of flesh produced here cost about 5d., the price of production in the second lot did not much exceed 4d., (4½d.); and in the third it was a little more, 4¾d.

3668. "With these observations of Mr Stephenson, we find the following numbers to express the daily increase in weight of the cattle during the period of fattening:—

	Average weight of the oxen before fattening.	Hay consumed per day per head.	Increase per head in 119 days.	Increase per day, and per head.
	lb.	lb.	lb.	lb.
First lot,	1115.0	49.7	247.5	2.0
Second lot,	1016.0	34.3	231.6	1.9
Third lot,	794.0	16.0	112.6	0.9

3669. "The weight of the several animals must also be taken into account, in seeking to estimate the increase realised upon every 100 lb. of live-weight during the fattening:—

	In the first lot, 100 lb. of live-weight, in 119 days gained	
... second,	...	22.2 lb.
... third,	...	22.8 ...
	...	14.2 ...**

ON MARES FOALING.

3670. May is the usual month in which draught-mares foal. They continue to work until the immediate symptoms of foaling are observed. These are, great loosening of the ligatures on each side of the root of the tail, and the appearance of

a waxy-like matter projecting from the point of the teats. The period of gestation is from 333 to 346 days.

3671. As it is impossible to predict a mare's foaling within a few hours, it is proper to put her into a loose-box by herself, and to watch her every night, as in *u* in the work-horse stable O, or in the out-house *g*, Plate II. Too many farmers neglect and even contemn such precautions, and allow their mares to foal in the stall in the stable, at the risk of having both them and their foals injured. The late Mr Airth, Mains of Dun, Forfarshire, told me that a mare of his, having been neglected to be watched at night, or even removed from the stable, was found in the morning lying on the floor with her womb protruded, and the foal smothered in it. The mare shortly after died in great agony. It is a remarkable fact, that few people have observed mares to foal, even though watching for the purpose, for somehow they contrive to foal when left by themselves for even a few moments. I have endeavoured for successive years to witness the foaling both of blood and draught-mares, and was always disappointed.

3672. A mare will eat with heartiness until the pains of labour seize her, when she suddenly lies down, foals easily, quickly, forcibly, requiring no assistance, starts to her feet almost immediately after parturition, takes up with, though licks but little at, her foal, and soon begins again to eat.

3673. The foal is not long of gaining its feet after a few staggering attempts on its long spindled shanks, but some time elapses before it can steady itself, in walking, or to lay hold of the teat. It should be assisted in its first attempt, to get filled with milk, after which it will lie down and sleep amongst straw, now replenished clean, until it becomes dry. The placenta soon drops from the mare, and should be immediately removed. The thin pellicle which covers the foal, is, when dried, like the finest gut-skin used by the gold-beaters; and it forms a good protection from the air, when applied as a plaster over the surface of a recent wound.

* Boussingault's *Rural Economy*—Law's translation, p. 615-17.

3674. The mare should have a drink of lukewarm water and oatmeal, and a few handfuls of corn, after parturition, and then left with the foal; and the warm drink should be given her for a day or two. For the sake of increasing her milk, she should be put to grass immediately after foaling, if not already on it; and should she foal before the grass is as far advanced as to support her well, she should have boiled turnips, or carrots and corn for a mess at night, and warm bran mashes during the day, (1444.)

3675. She should remain on grass without working at least for a month; by which time her body will have sufficiently recovered to bear the fatigue of labour. The work which a mare with a foal should do should interfere slightly with the important operations of the farm; having to suckle the foal every half-yoking, she should be employed singly, such as at sowing, and scuffling turnips and potatoes, and leading grass or other forage to the steading, and worked gently. When she works, the foal should be left by itself in the out-house, well-littered, until it become accustomed to be alone, rather than in a court or hammel, out of which it may attempt to escape and injure itself, as at first it almost goes distracted on being separated from its mother; and she also evinces great uneasiness for it for the first few days. Should there be two mares with foals, both should be worked together: the treatment of both being alike, little inconvenience will arise to work, from being taken out of yoke together to their foals; or one of them might be worked in the forenoon, and the other in the afternoon. A stout mare will be able to perform her own share of summer work, and bring up a foal at the same time; but should she be in a weakly state, which she will be when becoming old, or is over-worked, she should be put either to very gentle work, in half-yokings, or one yoking a-day, or be set idle altogether, and be constantly with her foal. She should not be neglected of corn, though idle at grass with her foal. Seldom any illness attacks a draught-mare while bringing up a foal, and as seldom anything is the matter with a foal. I had one work-foal, however, which, though safely and easily foaled, and seemed lively enough, could

never stand upon its feet, or suck a teat, and it died in the course of the day after it was foaled, though fed on cows' milk. A mare when thus deprived of her foal, should be occasionally milked, and kept on dry food for a few days, until the tendency of the milk to secrete subsides. When a mare dies in foaling, the foal may be well brought up by hand on cow's milk.

3676. The mare will be ready to receive the horse in 3 or 4 weeks at farthest after parturition. The first symptoms of heat is frequent convulsive opening of the vulva, and emission of a clear fluid. When a mare is touched in this state, she immediately presses towards the object that touches her.

3677. In presenting a mare to the stallion, caution is required to prevent her striking him with her heels should she refuse his attentions; and this consists simply in holding her by the head with a bridle across the outside of the stable door, while the stallion is kept within, and only allowed to snuff and pinch her flank. If she takes his teasing kindly, presses closer towards him, twitches the vulva, and emits, she is in proper season; but if she squeal and kick and make water, whenever he touches her, she is in an unfit state for him: but the tickling of the horse for a time not unfrequently confirms the season of the mare, though at first it may evince a doubtful issue. If in season, she should be taken to an open piece of level ground, and held by the head as long as the horse covers her, and the time occupied by a stallion in covering is considerable. A horse safe to use requires no encouragement from his leader to leap on the mare. Making a mare stand to the horse with a twitch on her nose is an unnecessary act of cruelty; for, if she will not voluntarily receive him, she will not become impregnated in an involuntary embrace; but many horses need assistance, which his keeper knows how to afford. One cover is quite sufficient at a time.

3678. In about 3 weeks it will be seen whether the mare has held to the horse; and should she again exhibit symptoms of season, simple and safe expedients may be used to secure her holding, such as throw-

ing a bucket of cold water upon her rump the moment the horse leaves her; or drawing blood from her neck vein while the horse is in the act of covering; or, what is better than these, unless the season is going rapidly off her, retaining the horse all night, and offering her a fresh cover in the morning; or, to adopt a different plan altogether, covering her with another horse, or another kind of horse—one or other of which expedients generally secures the holding, unless the mare is past bearing. I was told by a man who led stallions for many years, that the drawing of a long sigh, from both horse and mare, immediately after an embrace, is an infallible sign of the mare proving in foal.

3679. The circumstances that militate against a mare's holding in foal is too high and too low condition. Whenever a mare is seen to eject the semen as soon as the horse has left her, she will certainly not hold. Sometimes the fault is as much his as the mare's, when he is subjected to much travelling; and when he is not a good traveller, and has undertaken more service than he can easily overtake, he is often so much fatigued when brought to a mare, especially in the evening, as to be quite unfit for effective service. When the horse is observed to be in a state of lassitude, the best policy for the farmer is to give him and his leader a night's quarters, and to let him cover the mare in the morning, when he is comparatively fresh. Many farmers grudge maintaining a horse and a man all night, but much better incur that small expense than run the risk of a mare proving barren. When a mare has been covered three separate periods without success, it is needless to persevere with her for that year, as the foal will come too late next season, and a late foal is as objectionable to bring up as a late calf.

3680. The becoming barren is a casualty which befalls mares at very different ages. Some will continue to bear until after twenty years of age, whilst others cease at the age of ten. I had a powerful and handsome draught mare, which was put to the horse at five years old, with the view of producing a large number of valuable foals. She was put to the best horses

that could be procured, and she produced four very fine and valuable foals; but after attaining ten years of age she became barren, and no art that could be devised could bring her again into foal.

3681. Now that we have considered and described all the phenomena attending the parturition of all the domesticated animals of the farm, a few remarks on the nature of *labour*, as constituting the premonitory symptoms of parturition, may enable you to understand more clearly the rationale on which that important process depends. This is a subject with which shepherds and cattlemen ought to be well acquainted; and so ought the farmer, in order to perceive whether or not his servants understand their duty.

3682. The fœtus in the uterus of the female is produced by the impregnation of an ovum by the semen of the male. The period of gestation differs in different kinds of animals. The mare goes 11 months with young, the cow 9 months, the ewe 6 months, and the sow 4 months. And attention is required to be directed to these periods, which are natural, and cannot be altered to suit the convenience of man, that the young may not be produced in the cold and unpropitious season of winter, but in the milder and more favourable season of spring and early summer, inasmuch as those seasons present an abundance of grass, the most natural of all food for animals.

3683. At the termination of the period required for the complete development of the ovum, a new series of operations are entered on, for the purpose of giving birth to the fœtus which has been matured; these are included under the term *labour*. It usually commences at the completion of the determinate period of gestation; in some instances it occurs before that time, when it is called premature labour. In the comprehensive sense, therefore, we would define parturition to be, as observed by Dr Murphy—*the action of the uterus to expel its contents when the fœtus is sufficiently mature to sustain respiratory life.*

3684. There are many circumstances, depending either upon constitutional peculiarities, irregular formation, or upon accident, which may damage parturition or render it dangerous; hence labours have been divided and subdivided to meet those difficult conditions. Some adopt only two divisions. The first includes those labours which proceed regularly to their termination without interruption. The second embraces those who do not do so. The one is the rule, the other the exception; but as the exceptional includes several varieties, this second class is subdivided into corresponding heads. Denman's division is sufficient for our purpose, under the several heads of *natural, difficult, preternatural, complex.*

3685. Denman defines labour to be natural, "if the head of the fetus is present; if the labour

be completed in 24 hours; and if artificial assistance be not required." Labour is called *preternatural* when some other part than the head of the fœtus presents. It is called *difficult* labour when it exceeds 24 hours. It is *complex* labour when some accidental cause of danger occurs, which may render interference necessary.

3686. Applying these definitions to the ordinary cases of labour among the animals of the farm, I should say that *natural* labour is rare in short-horned cows and Leicester ewes, since both classes of animals usually require artificial assistance. Most other breeds of cattle and sheep, not requiring assistance, may be said to produce their young by means of *natural* labour. The mare may be said to be always delivered by means of *natural* labour.

3687. Short-horn cows and Leicester ewes are seldom overtaken with *preternatural* labour, since the head of the fœtus most commonly presents; and so it is with the other breeds.

3688. Short-horn cows are frequently subjected to *difficult* labour, since more than 24 hours elapse before they are delivered of the fœtus, from the time the premonitory symptoms of parturition present themselves. Neither Leicester ewes nor the females of the other breeds of stock are subject to *difficult* labour.

3689. Every breed of stock is at times subject to *complex* labour, since accidental circumstances occur every year to render interference necessary in cases of parturition.

3690. It is of importance that you should have a clear view of the whole series of phenomena which constitute parturition; for unless you perfectly comprehend the changes which are going forward in the womb, and have an accurate knowledge of the means adopted by nature to accomplish her purpose, you can never understand the principles of midwifery; your practice must be empirical; and, however indebted to chance you may be for success, you will always be exposed to the risk of committing some fatal mistake. In order to study parturition sufficiently, it is necessary to divide it into certain stages. The means by which the womb is opened is not the same as that by which the fœtus is forced through the pelvis; and the manner in which the placenta is separated and expelled is different from either; hence labour has been divided into three stages by Denman.

3691. The *first stage* is dated from the opening of the mouth of the womb to its complete dilatation. The *second stage* commences when the mouth of the womb is perfectly dilated, and terminates in the expulsion of the fœtus. The *third stage* is occupied with the expulsion of the placenta.

3692. For the purpose of opening the mouth of the womb to its complete dilatation, the *external muscular layer* of the womb slowly contracts for some time before labour has actually com-

menced, and draws the womb gradually to the pelvis. By this means also the bottom of the womb is maintained in its proper direction, and prevented from inclining too much to either side. This gradual contraction is unaccompanied by pain, and therefore is not taken notice of; but its effect in altering the size of the abdomen, and making it less prominent, has always been observed and noted as a premonitory sign of labour. The fibres of the womb also serve a useful purpose when the dilatation of its mouth commences: the bottom of the womb thus supported, the fibres on the internal surface contract more efficiently. It is the *muscles at the bottom of the womb* which chiefly effect the dilatation of the mouth of the womb and the expulsion of the fœtus—the fibres of the body and of the head of the womb remaining comparatively passive; and their united action is in the direction of the mouth of the womb; but there is still a necessity for the means by which the result of that action should be perfectly conveyed to it. This is accomplished by the fluid enclosed within the amnion, which acts with a distending power upon the mouth of the womb, exactly equal to the combined forces of the muscles. The muscular bands must also have the effect of expanding the mouth of the womb, by drawing it upwards. The circular fibres of the body and the head of the womb resist the effects of the bottom of the womb to distend them; and the force of their resistance is also communicated to the contained fluid. This force is therefore, as it were, reflected upon the mouth of the womb, so that the whole womb might be said to act as one muscle in dilating its mouth. In ordinary cases dilatation occupies a certain period of labour, (often a very lengthened one,) and the mouth of the womb yields very gradually to the power employed.

3693. Here nature interposes a means by which the danger attending the action of this power may be met and modified. If the womb exerted its full power upon its undilated mouth, and if the unyielding head of the fœtus were driven forcibly against it, the almost certain consequence would be, that the irritation would excite increased resistance, and ultimately terminate in inflammation of the mouth of the womb. To obviate such an effect, nature imposes a *fluid medium* between the power and the resistance. The liquor amnii, contained within the membranes, occupies the cavity of the womb, and when its parietes contract upon it, the force exerted (as explained above) by this means, is accurately conveyed to the mouth of the womb. When the latter dilates in the slightest degree, the fluid insinuates itself within the smallest opening, and expands it by a direct lateral pressure against its edges. The power of the womb is thus made to act in the most favourable manner for distending its mouth.

3694. The importance of the action of the liquor amnii depends on the well-known hydrostatic law, that the force conveyed by a fluid does not act in one direction only, but is distributed to every part of the surface to which the fluid

is applied, and it may be observed in the character of the pains during this stage of the labour. You will find that, however severely they may commence, they last but a short time, and the effect on the mouth of the womb is comparatively slight. If these short, though severe pains, be contrasted with the long-continued and powerful pains which follow them, after the liquor amnii, or water, is discharged, and the mouth of the womb is dilated, the difference in the effect will be sufficiently obvious.

3695. In regard to the *order* observed by the womb in the contractions which take place, and which may easily be ascertained experimentally. Thus: when the hand is passed into the womb after delivery, to remove the placenta, when necessary, we find that it may remain for some time in the cavity, without exciting its contraction, but the moment the hand is being withdrawn, the bottom of the womb instantly contracts, and as the hand passes along the vagina, the contractions are continued from above downwards; so also, in other instances, when the mouth of the womb is only irritated by the finger of the hand introduced into the vagina, and an attempt is made to dilate it, the bottom of the womb contracts, not the mouth. You have thus a very favourable illustration of the reflex nervous function. Hence, we infer that the order of interior contractions is from the farther end of the womb downwards, and that the action commences there.

3696. The *dilatable* condition of the mouth may be ascertained, if the fingers be passed within the mouth of the womb and separated. The edges yield readily to a moderate pressure; there is a very slight increase of temperature; and there is no tenderness or pain produced when the mouth of the womb is touched.

3697. But care should be taken that *rigidity* be not induced by too much meddling, making too frequent examinations, and attempting to dilate the mouth of the womb artificially. Some shepherds are too fond of showing their skill by too frequent displays of examination into the state of the mouth of the womb. The danger is that the mouth of the womb becomes inflamed and rigid, and the os tincæ grows hot and tender, is swollen, and also becomes rigid. Rigidity of the mouth of the womb may be natural, as in the case of the first pregnancy of the gimmer and the quey, which, however, gives way in repeated parturitions in future years. But sometimes the structure of the mouth of the womb is tough, which only gives way reluctantly; and it may even be cartilaginous, the edge perfectly unyielding from thickened contraction; and even when thin the resistance may be the same, and is to the touch like a hole made in parchment. Such cases requires great attention and constant watching on the part of the attendants.

3698. The womb acts differently when it has

to overcome unusual opposition occasioned by rigidity. The contraction takes place continuously for a certain time; but when the period which is usual to effect dilatation is exceeded, or when the mouth of the womb becomes irritated, the pains grow feeble, and the womb often suspends its action altogether. By this means an interval of rest is gained, when the irritation may subside, and the patient recovers from fatigue, which otherwise might end in exhaustion. When the action of the womb is renewed, after a suspension of this kind, the dilatation is often rapidly completed. Much confusion has arisen as to the duration of labour, in consequence of neglecting this fact. The commencement, however, is generally dated from the sanguineous discharge, which marks the first opening of the mouth of the womb; and all suspensions after this, occasioned by whatever causes, should be regarded as irregularities in the action of the womb, and not as indicative of the commencement of the continuous labour, which may be of very short duration previous to parturition.

3699. "It affords," concludes Dr Murphy, "an additional illustration of the principle which nature seems to observe in the dilatation of the mouth of the womb—to do nothing by violence. In all ordinary cases the liquor amnii, the water, moderates the action of the womb; but if there be an unusual resistance offered to it, and the waters are discharged, the increased action does not continue: it is suspended, and again renewed; so that the object is obviously to accomplish by time what nature avoids effecting by force."*

3700. From experiments made by M. Boussingault, it appears that mares weighing from 960 lb. to 1100 lb. produce foals weighing at birth from 110 lb. to 113 lb., about a ninth part of their own weight.

3701. The growth of foals while sucking for three months, increases from 112 lb. the mean, in the various ratios of 172 lb. to 241 lb., that is, from 1.9 lb. a-day to 2.7 lb. a-day, the mean being 2.2 lb. a-day.

3702. Foals increase less after being weaned than on milk. The increase on milk of 2.2 lb. a-day is decreased to 1.1 lb. a-day, exactly one-half.

3703. The increase of a foal to the end of the first year is 1.3 lb. a-day, the increase to the end of the third year is something under 1 lb. a-day. After three years complete, the period at which the horse has very nearly attained his growth and development, any increase becomes less and less perceptible. These conclusions in regard to the growth of the young horse differ very little from those in connexion with cattle.

3704. It appears that a young horse increases 12 per cent in live-weight on the weight of the food he eats.†

* Murphy *On Natural and Difficult Parturition*, p. 42-59.

† Boussingault's *Rural Economy*—Law's translation, p. 629.

ON THE PASTURING OF SHEEP IN SUMMER.

3705. When treating of the lambing of ewes, we left them with their lambs on new grass, to bring a flush of milk on them. (2555.) Since then they have continued to receive the best grass on the farm the weather allowed, until now, the beginning of the summer quarter, in May, according to our division of the agricultural year. The ewes and lambs continue together after the ewes have been washed and shorn of their wool, until the weaning of the lambs at the end of June, or beginning of July, according as the lambs become strong, and the ewes lean from being sucked; but early weaned lambs are found to stand the winter best.

3706. Ewes have more milk for their lambs on sown pastures of rye-grass and clover than on old pasture, which is at least a fortnight later in springing than the sown grasses. This is a serious objection against old grass for ewes at so early a period of the year as the middle of March; and as ewes ought to be well kept for at least a month before they lamb, it is essential to their thriving, as well as that of the lambs, that they be kept not only as well but better after they have lambed.

3707. Nothing is done with the lambs after their castration, (2571,) until they are weaned from their mother.

3708. The new grass, to be pastured by ewes and lambs, should be selected with judgment. That intended for hay should first be stocked, since new grass, moderately eaten down in spring, stools out, and affords a thicker cutting for hay than if it had not been so pastured. For the same reason, the new grass intended to be cut for horses' forage should also be earlier pastured than that to be pastured all the season. This arrangement gives both the forage and hay grass time to attain their growth when they are wanted, and it also gives the pasture time to gain as much strength as to support the ewes and lambs well during the season of pasturage. None of the new grass, however, should be eaten too bare; and rather than commit so great a mistake, even in a late season, the ewes should graze lightly on the best of the older

grass for a fortnight or so, till the rested new grass has grown again; and in such a case they should receive poppy-cake, which assists ewes in secreting milk.

3709. The pastures ought not to be allowed to be overrun with weeds. There are some weeds which sheep will not allow to grow up, being fond of them as food. These are the parsley, *Apium graveolens*; the rag-weed, *Senecio Jacobææ*—and so fond are sheep of this plant, that, wherever it is seen in pastures, it may be concluded that no sheep have grazed there while the plants were young—the plantain or rib-worts, *Plantago*, and several others. Every plant, not a pasture plant, should be cut down as weeds, such as all the thistles and docks, *Carduus* and *Rumex*, which are most unsightly weeds in sheep pasture. The perennial species of the docks are easily increased by seeds, as well as divisions of the roots, and the annual ones very easily by the seed, of which the plants produce a large number. The annoyance attending the maturation of the thistle tribe, and of all other seeds similarly constructed, as the rag-weed, dandelion, chickweed, is the making other fields foul with weeds as well as those in which they immediately grow, by the transportation of their seeds by the wind.

3710. No implement is better suited for cutting weeds in pasture than the common hand-hoe, fig. 266. In weeding pastures, two field-workers should be allotted to every ridge, and when they have gone from one end of the ridge to the other, they take a new ridge every time they arrive at the headridge.

3711. Should the *wether-hoggs* be retained on the farm until they are shorn of the fleece, they should be put on the best pasture to uphold the condition they have acquired on the turnips, and to maintain the strength of the staple of the wool until the fleece is taken off.

3712. Should *dinmonts* have been fed on the turnips, and it is desired to shear the wool before disposing of them, they should be treated in the same manner as the *wether-hoggs*.

3713. For the sake of the wool, the

ewe-hoggs should have good pasture until they are shorn of the fleece; and after that they may be put on rough or inferior pasture, as it is not desirable to make them too fat before being put to the tup in autumn.

3714. *Tups* should also have good pasture until they are shorn of the fleece; and after that they should have ordinary pasture, either by themselves or with the cows, but apart from the ewes and lambs and gimmers.

3715. A general remark as regards the pasturing of sheep is, that, as sheep crop grass closer and more constantly than cattle, they are not so profitable to graze, since they do not permit the grass to grow so full and freely.

3716. Leicester hoggs, before being clipped, are so loaded with wool, that, when annoyed by the ked, they often roll upon their backs with the feet in the air, and, when this happens in the hollow of a furrow, they cannot get up again. They are then said to lie *awkward* or *awald*. Should they lie for some time with their head down the hill, with the stomach full of food, they may soon die of apoplexy. It is disgraceful to a shepherd to allow even one sheep to die on lying awkward. He cannot prevent them falling awkward, but as long as rough sheep are grazing, he should visit them frequently. Sheep are not easily discovered lying awkward in a furrow, and therefore, when the field is examined, the ridges should be crossed, and the furrows viewed in length. An accustomed eye, however, can detect the hindhoofs elevated in the air, small as they are, at a considerable distance. Many dogs are quick in observing sheep in this state, and some I have seen run and take hold of the wool near the ground, and pull the sheep so far over on its side as to enable it to regain its feet. Sheep lain awkward for a short time will run away on getting up, but having lain a good while, voided much dung, and thumped the ground with the head and rump in struggling to get up, become fatigued, and on regaining their feet, appear stupified, and walk away as if light-headed. Shepherds cannot be too active on visiting the sheep in the pastures at this season.

3717. Lambs are subject to serious, and even fatal, injury on farms situate on the rocky cliffs of the ocean, from the attacks of the Raven, *Corvus corax*. This formidable bird approaches lambs when asleep, and left alone by their dams, grazing at a distance, and pecks a hole in the abdomen, and draws out the entrails. Should the lambs be awake on its approach, it picks out their eyes. Even hoggs, when fallen on their back, have been known to have had their eyes picked, and their entrails pulled out. The raven frequently builds its nest on cliffs overhanging the sea, and, when feeding its brood, becomes very bold, and will seize many animals which it will not meddle with at other times. Many a hare falls a victim to it. There is no way of destroying this bird but by shooting after long watchings, or by setting baited steel-traps near their haunts.

3718. The Carrion-crow, *Corvus corone*, will perch itself on the rump of a sheep infested with maggots, and in devouring them will pick the flesh off the sheep to the bone. I have saved many a young leveret from being destroyed by the carrion-crow.

3719. Carse farms afford no pasturage: the grass, being sown only for one year, is best suited for the soiling of stock, and the making of hay.

3720. Nor is it profitable to pasture the grass in the neighbourhood of towns, in which a steady demand exists for grass to be cut for forage from cowfeeders, carters, and cabmen.

3721. Dairy farms depend much on the richness and age of their pastures. The greater variety of plants a pasture possesses the better is it for the purposes of the dairy, and the greatest number of plants on the same space of ground is found on dry, deep hazel loam, which constitutes the best soil for yielding dairy produce of the finest description. It is probably to the great variety of the grasses, and also to the dry, deep sandy loams, so often met with in the haughs along the banks of the rivers in the glens of the Highlands of Scotland, that is to be ascribed the superior richness of the butter made in those localities. The haughs are very limited in extent, and are therefore capable of supporting but a small number of even the small cows of the Highland breed, which may account for the scanty supply of that kind of butter in the markets.

3722. As to pastoral farms, there are various circumstances which regulate the pasturage of them. Some pasturage is suited to the breeding,

whilst others are adapted to the bringing up of sheep. On what is called *bare* or *hard* land, ewes are preferred, and, to preserve room for them, their lambs are sold off every year. Some retain a few ewe-lambs to maintain the character of the ewe stock, whilst others purchase *great* ewes—that is, ewes in lamb—in lieu of the draft ewes they sell. Hard land bears scanty pasture, which, although sufficient and wholesome for breeding ewes, is unfit to support young sheep in condition, or to rear them to a proper size.

3723. *Soft* land is best suited to lambs. The wether-lambs purchased are reared until they become wethers, when they are sold in autumn to farmers who raise turnips to feed the sheep they do not breed themselves, or to English graziers, who fatten them upon grass. The ewe-lambs also purchased are reared until they are tupped, and then sold as *great* ewes to breeders, who purchase them to the extent of the old ewes they draft in autumn. Ewe-lambs are also purchased to convert into ewes, and after taking a few crops of lambs from them, are sold while yet young to be fed off on turnips in winter. Soft land will also put old sheep into good condition, but it is unsuited to ewes, because they become too high conditioned for a permanent stock, and are besides liable to be seized with the rot, on such pasture, in wet seasons.

3724. It is dangerous to change the ewe stock on some lands, because new ewes become diseased on new ground; and the fear of disease is so strongly felt that many proprietors will not allow the breeding ewes to be changed upon them, the incoming tenant being bound to take the standing breeding stock at a valuation.

3725. These various modes of regulating the pasturing of hill-sheep have probably originated from local circumstances, which cannot now perhaps be traced; but the *rot* has made such fearful havoc upon hill-sheep, and especially upon ewes, that every means have been devised to avert its occurrence, and a store-master is justified in trying them all to prevent so great a calamity. Other circumstances may have had the effect of introducing practices which otherwise appear questionable. For example,—Land may support ewes in keeping condition, which could not fatten wethers; and land may support lambs well, though not wethers. Young sheep may pine on land that supports wethers, because its elevation and steepness may fatigue them to travel over it, and its herbage may be too hard for them. Circumstances such as these affect the practice of different grazings, as well as the dread of the rot. If this view be correct, more general draining on hill-farms would render both pastures and practice uniform in similar localities. At all events, draining would give farmers liberty to follow their own plans, whereas, at present, they are under the control, not only of the seasons, but of the state of the soil. Let wet pasturage be dried, and rot will be subdued, whilst the miud, emancipated from dread, would

then adopt a general system of pasturing hill-flocks in accordance with sound principles.

3726. The brats or jackets should be removed from the sheep at the end of April, or beginning of May, according to the state of the weather, (1038.) Experience every year corroborates the use expressed of the brat in (1040), not only in maintaining the condition of the sheep by its warm covering, but also in protecting the wool from being washed by the weather, and in retaining the yolk, which is so essential to its preservation.

3727. Sheep on hill-pasture delight in summer to spread themselves over, and go to the highest point of their range. Ewes are restricted in their range by the lambs, which, when young, show little inclination to wander, and would rather lie down and sleep after being satisfied with milk. Hoggs keep much together, and do not wander far from their morning lair, wherever that may have been. Wethers go to the height of their pasturage at an early period of the day, and remain till dusk. Thus, when sheep of different ages are brought up together, how usefully they distribute themselves over their entire pasture; and where only one class of sheep are reared, they extend their range as their age increases, or food becomes scarce.

3728. On contiguous estates, where no march-wall defines the common boundary, the flock of one property may occasionally trespass on the pasture of another. Should this happen in the early part of the day, the shepherds should not dog off the strange sheep, as that will make them restless for days, but to wait till nightfall, and then point them gently over the march to their own ground, where they will take to their own lair. Sheep usually select a spot for resting at night, and it will mostly be the safest one for them, especially if they are aged sheep, and well acquainted with the ground. In fine weather they should not be disturbed in selecting their lairs; but in case of threatening storm, they should be directed to the sheltered side of the pasture, or even to the stells. With inclosed fields, sheep cannot go wrong in summer in selecting their lairs for the night.

3729. The uppermost parts of our mountain pastures, as well as many portions of lower elevation, consist of a soil very different in its nature from what is found in the valleys. This is *peat-earth*—not the soft peat of bogs, but the hard peat-earth which covers the mountains. The natural produce of this peat-earth is heath, consisting usually of 3 kinds, the *Calluna vulgaris*, common ling, the *Erica tetralix*, cross-leaved heath, and the *Erica cenerca*, fine-leaved heath. Peat-earth is only found in the colder portions of the temperate zone, and it was no doubt formed from the partial decomposition of several cryptogamic plants. Professor Jameson of Edinburgh was the first to propound the theory of the formation of peat-earth.* The pasturage on peat-earth would be greatly improved by draining.

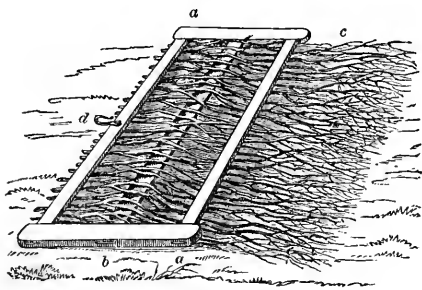
* Jameson's *Mineralogy of the Scottish Isles*, vol. ii. p. 120-57.

3730. It has long been observed that the application of lime on peat-earth produces abundance of white clover, *Trifolium repens*. The seeds must have lain in the soil in a dormant state, and their existence in elevated situations would imply that the pastures of our hills had been at one time better than they now are. Probably the woods which, it is known, once covered the greater part of our mountains, had sheltered the valleys near them as much as to allow the growth of the clover; and their subsequent destruction may have exposed the ground to the cold, to the destruction of the pasture, and to the formation of peat-earth.

3731. The top-dressing of mountain pasture with lime has been attended with success wherever it has been done. Pounded limestone would answer the purpose as well as slaked or quick lime, and it would be more enduring in its action. Mills for pounding it were erected about the beginning of the century on the estate of Struan, in Rannoch, Perthshire. After being pounded, the limestone was carried by a run of water to 3 different ponds, one above the other. The upper pond contained the grossest particles, and the lowest the finest part of the limestone, which there resembled clay or marl from its smoothness. On being put on the land at Struan, its effects were visible and much approved.* There is no use of putting the pounded limestone in water, and it should be applied in the state of powder upon the surface, and harrowed into the grass or pasture with a bush-harrow.

3732. A bush-harrow is easily constructed. It consists of a frame of wood having two longitudinal side-bars, *a a*, fig. 304, two cross-bars, and

Fig. 304.



THE BUSH-HARROW.

a third of a rounded form, *b*, which are all three mortised into the side bars by their ends, the whole forming a frame 7 feet in length and 3 feet in breadth. Stems of thorn, or branches of trees *c*, seven or eight feet long, are wattled through the three cross-bars so as to cause the twigs *c*, to rest hard upon the ground. A shackle, *d*, is fastened to the front-bar. The front-bar being thinner than the side-bars *a*, is strengthened by a spar under the wattles, to secure them, and is

bolted to it. A field-gate may be mounted in this fashion, but it is better to have a frame made for the purpose, to be ready to be wattled with fresh tough branches when required, for old brittle ones will not do. The bush harrow is worked by a horse attached by a swing-tree to the shackle *d*, by the driver walking behind the harrow with double reins in his hand; and on the branches rubbing against the powdered limestone, lime, or compost, or whatever may be the composition of the top-dressing, it is harrowed into the pasturage, some to the very roots of the plants.

3733. Limestone, sand, or gravel, occurs in Ireland in abundance. "They are, indeed, extensively diffused over the surface of that island," observes Professor Johnston, "as we might expect in a country abounding so much in rocks of mountain limestone. In the neighbourhood of peat-bogs, these sands and gravels are a real blessing. They are a ready, most useful, and largely employed means of improvement, producing upon arable land the ordinary effects of liming, and when spread upon boggy soils, enabling it, without other assistance, to grow sweet herbage, and to afford a nourishing pasture. The proportion of carbonate of lime which these sands and gravels contain, varies from 26 to 40 per cent.†"

3734. The top-dressing, whether of pounded limestone, ordinary lime, limestone sand and gravel, or compost, is best spread from the carts with the frying-pan shovel, fig. 233, the raised back of which preserves the hand from being injured by whatever material is contained within the shovel.

3735. The green pasture obtained by top-dressing mountain pasture, would maintain an increase of mountain stock beyond calculation. As the pasturage in the green grounds are reserved as hospitals for complaining sheep, for which the best food should be provided, it creates a want of sufficient extent of grass ground for young sheep, and prevents them getting full turns in winter, in case they should fall off in summer on the scanty grass; and it is better for the health of sheep to be kept lean, than to be reduced to leanness from higher condition, when means are not in the power of the store-farmer to maintain his flock in the high condition he would desire.

3736. As heath constitutes a principal food of the mountain sheep, *muir-burning* improves the heath for food. Store-farmers have long been in the habit of burning the heath on their farms every year, with the view of allowing it to grow again, that its young shoots may support the sheep in those parts of the grazings where is little or no grass. The injudicious manner in which the burning was long conducted, and the late period of the season at which it was done, destroyed not only the heath plant itself by the roots, but also the eggs of the grouse. Such destruction of the game determined the owners of

* Robertson's *Agricultural Report for Perthshire*, p. 62 and 309.

† Johnston *On the Use of Lime in Agriculture*, p. 24.

grazings to prohibit muir-burning altogether, and the consequences were that the heath grew so tall, that its top was beyond the reach of the young grouse from the ground, and the old plants put out so few shoots as to afford insufficient support both for sheep and grouse. Burning causes an abundant growth of young shoots; it is, therefore, the interest of both landlord and tenant that the heath should be so burned as to produce the greatest growth of young shoots. The question of burning being thus established on principle, the difficulty at first was to discover a mode which would produce the best results, but at length a good plan was discovered, and it is this:—Let that part of a hill-farm which bears heath be divided into 8 equal parts, if the whole farm forms one hirsell; and if it contains more hirsells, let each hirsell be divided into 8 equal parts, and in 8 parts, because beyond that number of years the heath plant grows so rigid as not to afford many new shoots, and it has then reached one foot in height, tall enough for grouse. The first portion of all the hirsells is burned in the same year, and the second portion in the second year, and so one portion every year, until the eight years have gone round. Every year the plants which were first burned will be putting forth fewer shoots as the expiry of the eight years approaches; by which time the first portion is burned again, as the commencement of a new series of years.

3737. In winter the snow covers the youngest shoots and protects them under it, while the older plants being above the snow, both grouse and sheep feed upon them; and in spring, on the melting of the snow, the young shoots, tender and nourishing, are ready for use. It is remarkable that the young plants of heath bear the frost better than the old, as was witnessed in the severe frost of 1837, which is a natural indication that the heath plant has only a period of utility.

3738. The usual mode of burning is to set fire to the heath on the *windy* side, when the blaze soon towers to a great height, and is seen at a great distance, and the plants crackle amidst the scorching heat; but the heat which produces the crackling destroys the plants by the roots, and the flame, fanned by the gale, runs along the ground, catching every bush of heath that presents itself the most readily, until a much larger space of ground is set on fire than is desired, and the conflagration becomes so extensive that the shepherd and all his family cannot extinguish it. They don't mind it, and retire, and the flame goes wherever the wind lists, till it has no more heath to consume, or until the wind lulls, or the rain falls.

3739. The proper way is to begin the fire along the entire *lee*-side of the portion, when the flame will not mount high, but, as it were, eat its way among the heath against the wind, and if any part escapes the fire, it is easy to take a burning brand and set it on fire. Let the burning be watched all day, and if the portion has not

wholly been burnt by the evening, let it be watched all night, and whenever the fire reaches its prescribed limit, let it be put out by going to windward and beating the flames, and pushing a board nailed across the end of a long and limber pole against the burning plants. Where the fire has not reached the bounds of the portion, let the flame burn until it reaches the limit. There is none more easy plan than this, and if followed on every heath farm every year, there would every year be grown a certain quantity of young heath in an excellent state, to support both sheep and grouse in the best condition the plant is capable of sustaining them.* Before beginning the burning, it should be considered from what direction the wind prevails, and the burning conducted against the wind. When the wind is from the E. or W., the burning should be begun on the *side* of the lot, but when from the N. or S., it should be begun at the *end*.

3740. *Law of Muirburn*.—"Persons making muirburn, or setting fire to any heath or muir in Scotland, from the 11th April to 1st November, will be fined 40s. for the first offence, £5 for the second, and £10 for every other, or suffer imprisonment for six weeks for the first, 2 months for the second, and 3 months for every subsequent offence, (13th Geo. III., 54, 4.) The tenant or possessor of the ground will be deemed guilty of the offence, unless he prove that the fire was communicated from other grounds, or raised by some one not belonging to his family, (*ib.* 5.) Proprietors of high or wet muir may burn the heather thereon, between the 11th and 25th April, or, if the ground be let, he may give permission to do so in writing, (*ib.* 6.) Which permission, however, must be recorded in the sheriff's books, (*ib.* 7.) Prosecutions for the above offence prescribe in 6 months, (*ib.* 14.)†

3741. *Weeds*.—The first writer of practice on the "Weeds of Agriculture," was Mr Benjamin Holdich, who classified weeds into 5 very natural divisions, in as far as the experience of a farmer would suggest, viz. :—1. Weeds which infest samples of corn, such as the corn-cockle, *Agrostemma githago*. 2. Fallow weeds, such as couch-grass, *Triticum repens*. 3. Weeds which are principally objectionable as they encumber the soil; or whose roots are annual, and whose seeds pass the corn-sieve, such as the charlock, *Sinapis arvensis*. 4. Weeds which never rise into the crop, nor come into the sickle, such as spurry, *Spergula arvensis*. 5. Weeds of pastures, such as yellow goat's-beard, *Trojanopogon pratensis*.‡ Other authors divide weeds into fibrous and fusiform rooted, annual and perennial; but it is of little moment to the farmer whether the weed that annoys at the present moment has a fibrous or long root, or is an annual, biennial, or perennial, as ordinary ploughing will eradicate almost every weed that infests cultivated fields. These are botanical distinctions, which may be studied as such, but give little insight into the weeds which infest a particular soil or crop.

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 640-8.

† *The Farmer's Lawyer*, pp. 193-4.

‡ Holdich's *Weeds of Agriculture*. Edited by G. Sinclair, 1825.

3742. It may be well to give a detailed account of the weeds which infest pastures. The biennial spear plume-thistle, *Cnicus lanceolatus*, is prevalent, and not infrequently the weted thistle, *Carduus acanthoides*, both in dry ground. In marshy pastures, the marsh plume-thistle, *Cnicus palustris*, is the most prevalent plant of the kind. The ragwort, yellow weed, or weebo, *Senecio Jacobaea*, is often seen in pastures, in deep dry loam. The tribe of docks is also numerous: the broad-leaved *Rumex obtusifolius*, and *acetosella*, sheep sorrel, are found on dry pastures, and the common sorrel, *R. acetosa*, and sharp dock, *R. acutus*, in moist and damp pastures. In moist pastures in low situations, the soft rush, *Juncus effusus*, and common rush, *J. conglomeratus*, are most frequent. The rush is prospectively removed by drainage, and immediately with the scythe. The great white ox-eye, or nowt-gowan, *Chrysanthemum leucanthemum*, and the common daisy, *Bellis perennis*, disfigure the pastures on low grounds, while the yellow nowt-gowan, *Chrysanthemum segetum*, acts the same part in upland pastures, and all indicate soil in a state of poverty. The common bracken, or fern, *Pteris aquilina*, prevails in upland pastures, where the soil is deep and dry. When growing together so thickly as to injure the grass, it should be removed as a weed, which may be done with the scythe, or by irrigation with water. When so thin as to permit grass to grow under it, it is an advantage as a shelter to sheep, and as protection to grass from frost, thereby cherishing it early in spring. Circumstances alone should guide you in the destruction of the bracken in upland pastures.* What constitutes the windlestraw of rich pasture is the dried stem of the crested dogs'-tail, *Cynosurus cristatus*, one of its most valuable pasture grasses.

3743. *The Sturdy*.—Sheep are subject to be affected with certain complaints on pasture, one of which is the *sturdy* or *turnsick*, which produces so much light-headedness as to cause its victims to turn round and seem stupified. When affected by it, the sheep separates from the flock, wanders into a corner of the field, feels aversion to put its head down to the ground, but keeps its head high and a little to one side. It seldom eats, and thus loses condition, and at length, becoming emaciated, falls into a ditch or burn, and is killed or dies, if neglected. Hogs are most affected by this disease, which seldom attacks large numbers, one or two now and then. What induces the growth of the hydatid, I do not know, for the complaint may be observed when hogs use little exertion in walking to obtain their food on turnip-land, and also when they wander over a large range of pasture. Accurate dissection of the head has proved that the disease is caused by a living animal in the brain, the Many-headed hydatid, *Hydatid polycephalus cerebri*. "Instead of a single head, there are a great number spread over the surface of the parasite, and opening into the same general cavity. When the sac

is distended, they appear only as opaque spots upon it; but a lens of no great power will give a distinct view of their heads, or rather necks, with the tentacula or barbs projecting from the apparent opening or mouth which forms the extremity of them. These hydatids vary in size from that of a pigeon's to a hen's egg. The wall of the cyst appears to be composed of 2 or 3 layers, the centre one of which seems to possess a muscular character. On examining them with lenses of a high magnifying power, their coats resemble paper made upon a wire frame, their muscular films so plainly and regularly interlace each other.† The complaint may be cured, though it is seldom attempted, the sturdy hogg being killed whenever it is seen to be affected. I was once tempted to try the experiment of a cure on a very fine Leicester gimmer, which was evidently with twin lambs, and would lamb in the course of a fortnight. The creature became so bewildered under the disease, that she was obliged to be brought into the lambing paddock, and fed by hand on cabbages and kail. On examining the head, I found a soft spot near the site of where a horn would be. I cut an incision into the skull round the margin of the soft spot, leaving only a small attachment to act as a hinge to the piece cut out, and on raising it, I distinctly saw the hydatid, which I extracted entirely with a small-cobbler's awl, the only instrument the shepherd or I had that would answer the purpose. Shutting the lid, covering it with a plaster of tar on a piece of linen, and putting a cap on the head, the gimmer was allowed to remain in the paddock and fed, and in the course of a few days I had the satisfaction of seeing her perfectly recover, and in due time bring forth twin lambs, which she brought up well, and continued to breed for several years after. The success attending this experiment, was probably owing to the proximity of the hydatid to the skull, which it had softened, by absorbing a portion of its substance; but when hydatids exist deeply in the brain, it is questionable that a cure can be effected. The Ettrick Shepherd recommends the insertion of a wire through the nose and brain into the hydatid, by which it would be destroyed, and the wire may be resorted to before any softening appears, and, from the situation of the hydatid, there may be no softness of the skull at all; and he says that "several years passed before he failed in this operation in any one instance."‡ But it is evident that no hydatid can be touched by the wire, but such as may happen to be situate in the direct line of its passage; and if a wire thus used will always destroy the hydatid, it follows that the hydatid must always occupy a particular part of the brain. A trocar and canula, like fig. 104, but smaller, are now used for tapping the hydatid. The sturdy is not an infectious disease, and I agree with Mr Parkinson, that it is not hereditary, for although I have seen several sturdy hogs, I never could trace any connexion of the disease with their parents. §

* *Journal of Agriculture* for October 1843, p. 143.

† Youatt *On Sheep*, p. 379.

‡ *Hogg's Shepherd's Guide*, p. 50.

§ *Parkinson On Live Stock*, vol. i. p. 412.

3744. *Blinding*.—This affection is sometimes produced in the eyes of sheep by the wind blowing into them the pollen of the grasses. The eyes become almost clogged up with pollen-dust, and such a degree of inflammation is sometimes set up as to cause the effusion of pus from them. In many cases the eyelids become glued together with the pus. No serious injury is produced by this accidental annoyance, though it is disagreeable to the sheep for the time it lasts. Wiping the eyes with a wet sponge affords great relief, which should be cheerfully bestowed by the shepherd once a-day. The annoyance can only last till the largest portion of the pollen is blown off at the termination of the period of the flowering of the plants, and it may not be of annual occurrence, as there may be no wind, but rain, during their efflorescence.

3745. *Sheep-pox*.—A troublesome and fatal disease amongst sheep has been brought into this country since the importation of live stock was permitted from the Continent. It is named the small-pox, because in its particulars it is very similar to that of the human subject. The disease has existed in Europe for many years, and in France and Germany its ravages have been very great. Since its introduction into this country, its mortality in some flocks has been to the extent of 90 per cent, and in numerous other cases 50 per cent. The first outbreak here was traced to two small cargoes of merino sheep, one from Hamburg, and the other from Tormingen in Denmark. These sheep were sold at Smithfield, in various lots, to farmers in different parts of the country, and it was thus that the disease was introduced amongst our flocks.

3746. "There is a singular uniformity in the period that elapses between exposure to contagion and the appearance of the eruptions, whether the animal gets it by inoculation or by simple exposure to diseased animals. This period is about ten days. On examination at this time, the papalæ stage commences—that is, little swellings resembling flea-bites are found all over the body, but mostly on the parts free from wool. These papalæ are preceded one or two days by red spots on the site of the papalæ. In the course of six days, vesicles or bladders form on the papalæ, and contain a fluid at first clear, and afterwards becoming more opaque. The chief point of difference in these vesicles, between the human subject and the sheep, is—in man the vesicles are rounded, while in the sheep, we find them flat, and much larger in proportion; and it is rarely the case in sheep that pustular secretion takes place, which is so common in man as to constitute a distinct stage of the disease. In about six days more, commences the stage of desiccation, that is, a scab forms, and the ulcers gradually heal by the end of a month. These are the stages of a case that ends in recovery; but when death takes place, it is either in the first or third stage. In the former, all the external symptoms are suppressed, and the animal soon dies, whilst in the third stage the animal perishes from exhaustion.

The danger is greatest when the papalæ are of a dark purple hue, or, running into each other, become confluent.

3747. "The disease is decidedly both infectious and contagious, so much so, that it might be possible to inoculate 1000 sheep from one having the disease well developed. It is not till the vesicles form that the disease becomes contagious, but it is probably infectious previous to this. It is uncertain when infection actually begins, but we are disposed to consider that there is danger as soon as any eruption takes place on the body, though unquestionably the danger is greatly increased afterwards."

3748. "As regards the cure of this disease, we decidedly object to the plan of inoculation simply as a means of prevention, whilst a flock is free from the disease, as by this means we propagate an infectious disorder, though in a mild form. . . . The plan we advise, after some experience and considerable reflection, is, as soon as the disease appears in a flock, to practise separation and examination as rigidly as possible, but, at the same time, to inoculate one or two sheep. Then, if we find that the disease extends in spite of our daily examinations, we shall have from these inoculated cases favourable lymph for the inoculation of the remainder. If some 12 to 20 cases of small-pox have really occurred, then, without any further delay, we advise inoculation to be practised on the remainder of the flock; for it should be borne in mind that the earlier cases are generally mild, and the disease increases enormously in virulence and fatality as it extends. The advantages in favour of this plan appear to be these: we may select the most favourable weather for the operation, and in the course of six weeks are free from further anxiety about the matter; the utmost care can be taken of the flock during the period, and the greatest vigilance exercised to prevent the spread of the disease to other flocks—a care and vigilance which it may be difficult to adopt through so long a period as the system of continual turning might demand. Besides which, it should be remembered that there are at least three ewes probably to one wether sheep, and these ewes being of course kept for breeding, it is of the utmost importance to select the earliest and most favourable time for receiving the disease, and not to run the risk of their getting the disease naturally just previous to lambing. It is quite a mistake to suppose that the risk of spreading the infection is increased by inoculation—in fact it is lessened, for the disease becomes milder, having a mortality ranging from 2 to 10 per cent. It is also circumscribed, and necessarily entails the utmost vigilance, and prevents the sale of sheep from the flock for a given period of twenty-one days."*

3749. The only means of avoiding being continually annoyed with this disease, and of preventing its circulation, is the prevention of the importation of diseased sheep from abroad, and

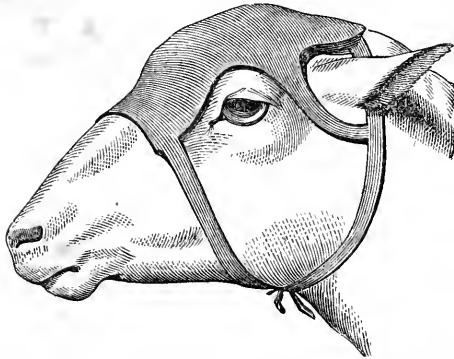
* *Gardeners' Chronicle* for April 14, 1849.

the prohibition of the sale of *infected* animals in the country, as well as those *actually labouring under the disease*. The former means might be used in our insular position by strict surveillance, but the latter could scarcely be made available without inquisitorial inspection of the flocks in the possession of both breeders and dealers.

3750. Two acts connected with this subject were passed by parliament, which received the royal assent on the 4th of September 1848, and are to continue in force only for two years, from 1st September 1848 to 1st September 1850. One act prohibits the importation of sheep, cattle, horses, &c., affected by the disease; the other imposes certain specified penalties on those who should expose for sale any stock suspected to be infected with any contagious disease. The penalty is £20 for every offence of exposing such stock for sale, knowing them to be diseased, and a penalty of £5 for each offence in obstructing persons in the execution of this latter act.*

3751. *Scalded heads*.—Sheep are much infested in summer with flies. As a protection to the head against them, the simple cap, or hood, fig. 305, is effectual. It may be made of stout linen,

Fig. 305.



THE HEAD-CAP, OR HOOD, FITTED ON THE SHEEP.

and fastened with 4 tapes tied crosswise under the chin, or of leather, and buckled at the same place. Leicester tups should not be without these caps in summer, especially when grazing near woods; and as tups are occasionally fond of boxing each other, any skin that may thereby be abraded on the head will receive immediate and effectual protection, from the air and flies, by the cap.

Fig. 306.



SHEEP BOT-FLY—*ESTRUS OVIS*.

3752. *Bots*.—Sheep are troubled with bots as well as cattle. The fly is called *Estrus ovis*, the sheep bot-fly, fig. 306. It is a smaller species than the cattle-bot, being about

5 lines in length. It is supposed to deposit its eggs on the margin of the nostrils, and whenever it does so, the sheep lies down upon dusty bare spots, holding its head close to the ground, or, when a number are attacked at the same time, they form a dense phalanx, with their noses pushed towards each other. The warmth and humidity of the nostrils very soon bring the eggs to maturity, and the larvæ find no difficulty in gaining their way into the frontal maxillary, and other sinuses and cavities of the face. There they adhere by means of 2 hooks, the secretions

Fig. 307.



SHEEP BOT LARVA—*ESTRUS OVIS*.

of the cavities constituting their food. In time they wriggle down the nose and fall on the ground, in which they undergo their future transformation. The larva, fig. 307, is flat on the under side, and convex above, of a delicate white colour, without spines of any kind, save the terminal hooks already mentioned. A series of black transverse spots are visible on the under side, covered with rough points.

3753. *Keds*.—The *ked* or *keb*, the sheep spider-fly, *Melophagus ovinus*, is an insect so well-

Fig. 308.



SHEEP KED—*MELOPHAGUS OVINUS*.

known in its nature and habits, that a particular description here seems unnecessary. It is magnified at *a*, fig. 308, the line *b* showing its natural size. It penetrates the skin and buries the anterior part of its body in the flesh or fat of the sheep, where it continues to subsist and enlarge. Its tough skin renders it difficult to be killed by pressure; and when its body is bisected by the shears, the buried part instantly emerges and runs about quickly in a manner almost incredible, but nevertheless it soon dies. Another remarkable circumstance attending the tribe of *keds* or *ticks* which belong to the family of Hippoboscidae, and are included among the dipterous or 2-winged insects, though they are wingless—is, that the young is retained in the body of the mother until it becomes a pupa, there being no other instance amongst other 2-winged flies of the period of gestation extending beyond the state of larva. This peculiarity has caused the Hippoboscidae to be termed *nymphiparous* or *pupiparous* insects.

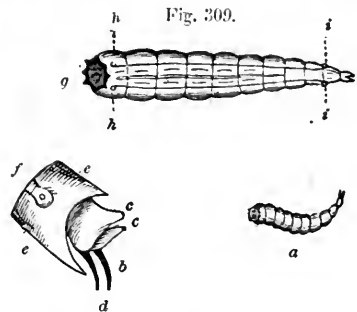
3754. *Blow-flies*.—Much more dangerous tormentors of sheep are *blow-flies*. When sheep are *struck by the fly*, the symptoms of disease cannot be easily misunderstood. They almost constantly hang down their heads, sometimes turning them on one side as if listening; shake the tail with a quick jerking motion; run rapidly

* *Journal of Agriculture* for March 1849, p. 670.

from one place to another, and, in doing so, at times stop suddenly and stamp with the fore-feet. The flies deposit their eggs on any bare skin they can find, and, failing that, on the wool on the rump, below the tail, and about the groins. If the larvæ are left undisturbed, when in large numbers, in two days they will destroy the sheep, having in that short time eaten the flesh into the very bones, and sometimes exposing the entrails! Warm moist weather, in fields enclosed by woods, and in the bottom of dells, are the circumstances and places most favourable to their attacks. The smell arising from excrementitious discharges, the glutinous matter left after milking ewes, and long wool, are all attractive objects to blow-flies. A shepherd ought to be able to detect sheep that have been struck by the fly the moment he enters the field. Dogs have been known to point them, as truly stated by Mr Price. "A looker's dog," he says, "when properly trained, the moment he enters a field in which are any sheep struck by the fly, instantly singles out the diseased animals, and runs up to them, as much as to say they ought to be caught."* Dogs require little training to do this, partly because the symptoms which struck sheep exhibit are unequivocal, but more probably from the peculiar smell which maggots doubtless emit; or the sheep themselves may emit a peculiar odour after being struck. The Etrick Shepherd is of opinion (and it is a probable one) that flies give a preference to one sheep over another, probably on account of the selected sheep being either actually subjected to diarrhœa, or emitting such a peculiar flavour along with its perspiration, as to be attractive to flies, and which may be indicative of a predisposition to disease.† It is culpable in a shepherd to allow any sheep to be dangerously injured by the fly. He cannot prevent their attack, but he should be able to detect it before it proves serious in its consequences. The sheep should be carefully observed one by one when the flies are active, and being gathered in a convenient part of the field, the suspected ones should be caught with the crook, fig. 224, and examined, and every maggot removed by the hand. As maggots are not killed by being thrown on the ground, they should be collected in some vessel, and destroyed either by being crushed by some hard substance, or by having boiling water poured upon them. I have seen a shepherd fill his hat with maggots, in the course of an hour's search amongst a small flock of Leicester hogs. Should the maggots have broken into the skin, rubbing the part with a strong solution of corrosive sublimate, or a strong decoction of tobacco-liquor and spirit of tar, will check a farther attack on that part; and should the part affected be larger than is seen between the sheds of the fleece, the wool should be removed with the shears, and the corrosive sublimate applied upon, and around, and rubbed into, the wound. Should the wound, on healing, indicate a dryness of the skin, in consequence of the application of the corrosive sublimate, an ointment of tar and lard will soften it, and keep

off the flies. Mr George Mather, shepherd, New Scone, recommends a wash containing arsenic, which I have no doubt would prove effectual; but I have a great aversion to using arsenic in any shape on a farm, and cannot recommend it to be used in this case.‡

3755. The most dangerous, perhaps, of all the flies is the checkered blow-fly, *Sarcophaga carnaria*. It is somewhat larger and more elongated in shape than the common blue-bottle fly; general colour changeable gray; thorax with black longitudinal lines; abdomen covered with black quadrate spots, which give it a tessellated appearance; body pretty thickly beset with strong hairs. It produces its young alive; hence the appearance, so often considered unaccountable, of maggots in a short time after the sheep have been examined. "The larva, when full grown," says Mr Duncan, "is scarcely half an inch in length, as at a, fig. 309; the head b is small and mem-



MAGGOT OF THE CHECKERED BLOW-FLY—*SARCOPHAGA CARNARIA*.

branous, having two fleshy prominences above, with a small nipple-shaped knob *c c*, so that they bear a perfect resemblance to small mammae. Beneath these mammiferous protuberances are two strong black movable hooks *d* placed by the side of each other; *e e* is the first segment of the body, and *f* one of the anterior stigmata. The principal use of these hooks is to tear off and separate the fibres of the flesh on which the creature feeds. The last segment of the body *g* is, as it were, cut across. Two large air-vessels may be seen running along each side of the body, terminating at both ends in breathing-holes, *h h* and *i i*.

3756. The description of the maggot of this fly will serve for that of the other flies about to be mentioned.—*Musca Cæsar* is readily known by its brilliant green hue, which has a silvery play of colour when seen in certain lights.—*Musca vomitoria*, common blue bottle-fly or blow-fly. This fly is well known in our houses, and may easily be identified by its buzzing noise when on the wing. "This is the species," observes Mr Duncan, "of which Linnæus affirmed that 3 individuals could devour the carcass of a

* Price *On Sheep*, p. 472, note.

† Hogg's *Shepherd's Guide*, p. 106.

‡ *Prize Essays of the Highland and Agricultural Society*, vol. x. p. 221.

horse as soon as a lion. There is no doubt that we must impute to it a large share of the injury our flocks sustain from this tribe of insects."—*Anthomyia lardaria* is rather more than half the size of the blue-bottle fly, and of a bluish-black colour; thorax with longitudinal lines, and abdomen slightly tessellated. It is very common in low sheltered woods, and is doubtless often associated with the other in preying on living subjects.* It is said that the green-fly first attacks the sheep, and is succeeded by the more greedy blue-bottle fly, which, having made a suitable place, is, in its turn, succeeded by the checkered blow-fly.

3757. *Sheep worried by dogs.*—Sheep on pasture are sometimes worried by dogs, and the destruction happens most frequently early in a summer morning. Experienced dogs go singly to do the mischief, and take care not to bark while engaged in it; their only object seeming to obtain a feed of mutton. Dogs most addicted to the vice of worrying sheep are mastiffs, bulldogs, bull-dog terriers, and lurchers bred from a colley, and they are most prone to it when they escape from the chain, which detains them as watch-dogs. An old colley addicted to this vice practises it with consummate art, and obtains mutton with the least trouble to himself, and commits the least extent of mischief. Pointers when hunting, and especially self-hunting, are very apt to chase sheep when running from them. The part of the sheep commonly seized by the dog is the throat, which he tears open, and eats the flesh to the neck-bone; and were he to content himself with this morsel, or to satisfy his appetite, the loss would not exceed the value of one sheep; but the propensity to destroy seems only bounded by the number of the flock; he worries some to death and bites a great many more. The destruction is probably aggravated by the conduct of the sheep themselves, which run away in a body from the dog; and in fear of losing the rest whilst running down one, he leaves the wounded one on the ground and pursues the others, seizing the nearest him, one by the back, another by the throat, and a third by the haunch, until a great number are lamed by bites. It is rare that a dog feeds upon more than one sheep, as he is probably scared by some circumstance, before he has time to break into another. When a lamb is run after, it is so easily overtaken that the dog tears its neck open at once and satisfies himself upon it. I am not aware that a dog which worries sheep can be deterred from the practice by any means—certainly an old dog cannot—and the only fate that should befall so hardened an offender is the rope or the gun. But a young dog, especially a pointer, may be deterred; and the most effectual way, I believe, of doing it, is to couple him for a few days to the carcass he has worried, and cause him to drag it about with him; or, in a hill country, to couple him to a black-faced ram for some days, with a sufficient length of chain to allow the ram to turn about and butt him severely with its horns. In every

attack of sheep by dogs there are comparatively few deaths to the number injured, and, were time afforded, most of the bitten sheep would most probably recover; but the usual custom, in the excitement which such an occurrence creates, is to kill the sheep with the view of preventing the total loss of the mutton by the sheep dying—and were they to die in the blood, the mutton would be rendered unfit for use. There were once 9 of my Leicester ewes worried by a dog, from 3 of which the blood was drawn on the spot, and the shepherd would have bled other two had I allowed him. From the recovery of these bad cases by the means used, I was persuaded that the 3 which were killed would have recovered had they been permitted to live. There is no doubt, however, that sheep which have been run and worried ever so little are a long time, if ever, of recovering their customary composure; and on this account alone, the owner of a dog that runs other people's sheep should be severely fined over and above the value of the sheep actually injured.

3758. Besides the sheep, the pasture on which they feed is infested and injured with a host of insects. The grub of the meadow crane-fly, *Tipula oleracea*, fig. 223, destroys the roots of grass as well as of oats, (2504.) The year 1762 was called the *wormy* year, in consequence of the depredations occasioned by this grub in Selkirkshire. It again appeared in 1802, 1812, 1824, and 1826, and in Peeblesshire in 1830.†

3759. The ear-beaked weevil, *Otiorhynchus sulcatus*, about 5 lines in length, of a brownish black colour, and incapable of flight, in consequence of the junction of the wing-cases, produces a larva nearly half an inch long of a whitish colour, thick and fleshy, and thinly beset with long bristles, which is for the most part subterranean, and lives indiscriminately on the roots of all gramineous plants.

3760. The common kinds of ants, *Formica fusca* and *rufa*, sometimes almost usurp the entire dry pasture; and it is difficult to extirpate them. Perhaps as effectual a mode of doing so of any is to notch a piece with two cuts of the common spade, fig. 237, out of the top of each mound, in the beginning of winter, and expose its contents to the weather.

3761. The caterpillars of several butterflies also destroy pasture plants. The meadow brown-butterfly, *Hipparchia janira*, whose wings expand nearly 2 inches, produces a light-green caterpillar, with a white line along each side, which prefers for its food the smooth-stalked meadow-grass, *Poa pratensis*, one of the most nutritious grasses for cattle; and the caterpillar of the large heath butterfly, *Hipparchia tithonus*, considerably less than the preceding, is of a green colour, with a reddish line on each side, and a brown head, and feeds on the annual meadow-grass, *Poa annua*, which forms the chief cover-

* *Quarterly Journal of Agriculture*, vol. ix. p. 58, 63.

† *New Statistical Account of Scotland—Selkirkshire—Yarrow*, p. 41.

ing of our meadows and pasture-lands. The caterpillar of the antler-moth, *Charaxes graminis*, is brown or blackish, with light-yellowish stripes along the back and sides, and attains about one inch in length. It lives under ground, and feeds on the roots of grass—and the injury it does to pasture-land in hills is sometimes very great—but it avoids low-lying damp meadows. The effects of its ravages are very similar to those produced by the burning of heath.

3762. But the greatest devastation of this kind is committed by the larvæ of the common cock-chaffer, *Melolontha vulgaris*, an insect but little known in Scotland, though sometimes it occurs in countless myriads in England and Ireland. There this beetle "wheels its droning flight" in the summer twilight. Fig. 310 represents a female *a*, about an inch in length, oblong and convex, the head reddish in front, the hinder part pitchy black. As soon as fecundated, the female makes holes in the ground

Fig. 310.



COCK-CHAFERS—MELOLONTHA VULGARIS.

about half a foot beneath the surface, and lays a cluster of white eggs *b*, tinged with dirty yellow at the bottom of each hole, and she lays a great many in all. The larvæ *c*, which proceed from them, are of a dingy-white or yellowish colour, and soft and inactive. They are $1\frac{1}{2}$ inch in length, and furnished with a pair of powerful mandibles. The perfect insect is short-lived, but the larvæ survive for 3 years, passing into a state of perfect repose in winter, and recovering their activity in spring. So completely do they sever the pasture from the soil that the turf may be rolled up in large sheets. Another chafer, named *Amphimalla solstitialis*, produces a grub very similar in its habits to the one described, though smaller and more restricted in its distribution.*

3763. Moles, *Talpa Europea*, often disfigure the face of the richest parts of pastures, not by

feeding on the grass, as many insects do, but by throwing up mounds of earth upon it when digging their galleries under ground in pursuit of their favourite food, the earth-worm, and many of the larvæ of insects. They are thus useful and injurious at the same time—useful in devouring the larvæ of insects on the surface of the ground at night, and which fall or go into their galleries in the day—and injurious in destroying the earth-worm, which is useful to the soil while alive, by keeping it open to the air and moisture, and when dead by manuring it with its body; and also injurious in covering the surface of the grass with earth—for, as to the value of the top-dressing which the grass receives in this way, it is received at the expense of the finer and richer part of the mould immediately under the grass plants, which, by its removal, are thus deprived of nourishment at the roots, where it is of most use to them. We have only to look at the scorched appearance of the ground in dry weather along the lines of the galleries, and find ourselves sinking nearly ankle-deep in the ground undermined by moles, to be convinced that no top-dressing will ever compensate for the injury done to the pastures of low farms. "A course of thirty years' observation," says the Ettrick Shepherd, "over an extensive district of the south of Scotland, and hard-earned experience, have convinced me, long ago, of the pernicious effects of destroying the moles on sheep pasture.

The most unnatural of all persecutions that ever was raised in a country is that against the mole, that innocent and blessed little pioneer who enriches our pastures annually with the first top-dressing, dug with great pains and labour from the fattest of the soil beneath. The advantages of this top-dressing are so apparent, and so manifest to the eyes of every unprejudiced person, that it is really amazing how our countrymen should have persisted, now nearly half a century, in the most manly and valiant endeavours to exterminate the moles from the face of the earth. If a 100 men and horses were employed on a common sized-pasture farm—say from 1500 to 2000 acres—in raising and driving manure for a top-dressing of that farm, they could not do it so effectually, so neatly, or so equally, as the natural number of moles on that farm would do of themselves. That pasture land is benefited by a top-dressing, no man, I think, will attempt to deny. That the moles give it that top-dressing, as few will deny."† No one denies the benefit of top-dressing to pasture grass; still, if its benefit is to be derived at the expense of the soil itself, many would question the prudence of permitting it, merely because it would give the farmer no trouble, and incur no cost.

3764. Moles are caught in traps expressly made to fit into their galleries, and persons make a profession of entrapping them in the summer season, who are called *mole-catchers*. Mole-catching is generally taken for the season by such persons, and the price on an extensive lowland farm is 5s. the 100 acres. No endeavours

* *Quarterly Journal of Agriculture*, vol. ix. p. 565-572.

† *Ibid.* 640-41.

should be made to extirpate the mole, but only to keep their numbers down to a moderate extent. A few mole-hills here and there do little harm, but acres of good soil converted into a burrow, as a preserve, for the pleasure of moles, is too much of a good thing.

ON THE PASTURING OF CATTLE IN SUMMER.

3765. The cattle of all ages, as accommodated in the steading in winter, (1082) to (1085,) remain there as we left them (1219,) until the grass is ready to receive them, which, in ordinary seasons, is at the end of May or beginning of June; but, in late seasons, when the turnips are expended before the grass is sufficiently long to afford them a bite, cattle are put to grass before it is ready for them. In case of such an untoward event happening, it is the duty of the farmer to provide against it, by purchasing extraneous food for his cattle, such as oil-cake; or giving them beans or oats; or disposing of the fattening cattle in time to leave a sufficient quantity of turnips for the young cattle and cows until the grass is ready to receive them. In the state of confinement in the steading, cattle thrive better on a variety than on the same food; and yet when on grass they require no variety of food, and thrive the better the longer they live upon it, unless that a change of pasture is desirable when it becomes bare. Grass is thus evidently the natural food of the ox, and his anatomical structure is peculiarly adapted for that sort of food. Whatever kind of food he receives in winter partakes of an artificial character; and being only a succedaneum for grass when it cannot be obtained, the artificial food should be made as palatable to him as circumstances will allow, whether by variety or superior quality. This consideration shows the propriety of M. Boussingault adopting grass, or rather hay—grass deprived of its water, as the standard for comparing the nutritive properties of the different sorts of food given to stock on the farm.

3766. The fat cattle having been disposed of, (3609,) the pasture should be judiciously distributed amongst the remaining stock of cows, year-olds, and calves; and first as to the *cows*. They

should have the best pasture, the object of keeping them being to breed calves, and afford plenty of milk to bring them up. The more milk they yield, therefore, the better will the calves prove, and the more profitable will they themselves prove after the calves are weaned. Cows in summer are treated in an opposite manner by different people, one taking them into the byre at night, and even at all times milking them there, and another allowing them to lie out all night, and milking them in the field. Whichever mode is adopted, it should be kept in mind that cows are peculiarly susceptible of sudden changes of temperature, especially from heat to cold, and from drought to rain; so that, when cold or rain, or both, come together, which is the common circumstance, they should be brought into the byre. For some time after they are first put out to grass, they should be housed in the byre at night, when they are milked there, and again in the morning before they are let go into the field; and when they are milked three times a-day, they should be milked in the field at mid-day. In dairy districts cows are milked twice a-day, morning and evening, and in breeding districts thrice a-day, morning, noon, and night. After the nights become warm, I have found it conducive to health, and it is both a rational and a natural custom, to let them lie in the field all night, and to milk them there also at stated hours—three times every day, the shepherd or cattle-man bringing them to the most convenient spot of the field to be milked. The lying out always in the field no doubt imposes more labour on the dairy-maid and her assistants, in carrying the milk to the calves, and to the dairy after the calves have been weaned; but I am persuaded it is an excellent system for the health of the cows. The cows rise from their lair at daybreak, and feed while the dew is still on the grass, and by the time of milking arrives, say 6 o'clock, they have partially filled themselves with food, and stand contented, chewing the cud, while the milking proceeds. They then satiate themselves, and by 9 o'clock lie down in a shady part of the field, and chew their cud until milking time arrives at noon, when they are again brought to the same spot and milked. Feeding again, when the heat of the afternoon arrives, they stand in the coolest part of the field, whisking away

the flies with their tail and ears. The evening milking takes place about 7, after which they feed industriously, and take up their lair about sunset, and chew their cud, and in the morning they rise and feed before being milked. Apprehension exists that cows injure themselves by eating grass wet with dew; but it is a fact, which is not so well known as it should be, that bedewed grass before sunrise, and grass after it is dried by the sun, are alike uninjurious to cows; and it is only when the dew is in the act of being evaporated, immediately after sunrise, that grass proves injurious to them. Cows which lie out all night eat the grass while it is yet wet with dew; whereas those kept in the byre, on being let out after being milked, are let out just at the time the dew is being evaporated by the sun, and when the grass is in the coldest state. It is thus consonant with the fact, that the cows kept in the byre at night are alone affected with the grass when it is wet with dew; and, being hungry, they eat the cold damp grass with avidity and much relish, while cows which lie out all night are not affected by the wet grass. Circumstances, however, should rule the custom of lying out or housing at night. In a cold upland district, or in exposed situations, devoid of shelter in the fields, so susceptible creatures as milk-cows should not lie out at night; and as but very few nights are really warm in such situations, it is safer to put them into the byre, and ventilate it well in the warm nights that may occur. In favourable situations, one circumstance is worthy of attention in determining the practice of lying out and housing, that the housing causes the trouble of providing supper for the cows; and this provision not only implies the cutting of the forage, whatever it is, but also preparation of the plant in the field. Excepting a change of pasture—and the change should always be for a better one—the treatment of the cows is the same throughout the summer, and even to the cool evenings at the end of autumn. As the milk falls off, the noon milking is dropped; and, when the evenings become cool, the cows are brought into the byre at night, milked there evening and morning, and graze during the day. When this takes place, supper must be provided for them in the byre after the evening milking is over, and they should also be littered for the night.

When cows occupy the byre every night, litter should be provided for them; and should the straw be all expended, a number of light materials will answer the purpose, such as coarse grass cut from plantations and bogs, ferns, sawdust. The cows of a breeding stock will be mostly served by the bull before they go out to grass, though a few of the later ones will yet have to be served. It is the duty of the cattleman to attend to these, and see them properly served (2233) by the bull, as also those the season of which may return.

3767. Young cattle are not put on new grass, but on the one or two year old grass; and although all ages of stock are fondest of new grass, all the stock of a farm cannot have it; and the older pastures are quite good for all grazing purposes, and will generally stand the eating, during the summer, better under all circumstances of weather. The pasture of the young cattle should be changed as well as that of cows, whenever it happens to be eaten rather bare: not quite bare, for no stock ought to be allowed to remain as long in the same field as to allow the grass to become bare by too much and too close eating.

3768. On this account, moderately sized fields, of 20 to 25 acres, answer best for grazing stock, as one can be rested for a fortnight or three weeks until the grass grow again in it, whilst the others are being pastured. In this manner of treating pasture, the stock obtain a tasting of new fresh-grown grass at intervals during the season, which has the wholesome effect of an alterative upon their system.

3769. Young cattle require little tending while on grass; nevertheless, it is the duty of the shepherd, as he goes his daily rounds to the sheep, to ascertain every day that the young beasts are in good health, and have plenty of food, plenty of water, and are in security within the fences.

3770. Cattle, which do not crop the grass close to the ground, graze well with horses or sheep, both which crop the grass close. The lips of the ox are stiff, and cannot lay hold of the grass while they cut

it with the teeth, like the sheep and horse; but their tongue is very prehensile, and with it they embrace every mouthful of grass, and, drawing it towards the mouth, retain hold of it until the incisors of the under jaw sever it from the ground with a jerk of the head upwards, and the tongue then sweeps it into the mouth. The grass at this time receives very little mastication, and is swallowed and deposited in the paunch; when this is full, the ox eats no more for a time, and prefers to lie down in a shady place, and chew the contents of the paunch in the pellets forced up into the mouth, (1652.)

3771. Calves are put on grass at the same time as the other cattle, whether weaned or not. By that time the oldest ones will be ready for weaning; but although ready, the herd of calves should be kept together at first, in a small paddock of grass near the steading, where the younger ones are served with milk, and the older with grass, and both are at hand to be put into the shedded court at night, until the weather becomes warm enough to permit them to lie out all night. Calves are very susceptible of cold, especially as long as they are on milk, and receive more injury from exposure to it than most breeders seem to be aware of. Much rather keep them in their court at night one night longer than necessary, after the warm evenings have arrived, than cause them to lie out one night too soon in the cold.

3772. Grass-land requires peculiar management to render it the most available as pasture in every variety of season. The circumstances which most injure grass are *overstocking* and *continual stocking*. The most effectual method of avoiding overstocking is to have no more stock upon the farm than its grass will in summer maintain in good condition; and to avoid continual stocking, the stock should not be allowed to remain too long in the same field. The safest principle to treat each grazing field, is to stock it at once, so as it shall be eaten bare enough in a short time, say in a month, and then to leave it unstocked altogether—*hained*, as it is technically termed—for perhaps a fortnight, in order to allow the grass sufficient time to afford a good bite for cattle. One advan-

tage of this plan is, that the stock at periodic times during the grazing season enjoy new-grown grass; and another, that no growth of the grass is so long pastured as to cloy the appetite of the animals, or become foul by being constantly trodden upon. That this is a rational and natural mode of pasturing grass-land is evinced by stock delighting to consume new-grown grass; and every animal loathes grass which has been long trampled and dunged upon, and the breath passed over it times out of number.

3773. Another principle that affects the method of treating pasture land, is the difference in the effect of cropping the grass which the different animals employ; cattle cropping high, and sheep nibbling low, while horses bite both high and low. This is a wise distinction between the two classes of our ruminants, the sheep being suited to the short pasturage of mountainous regions; their mobile lips enabling them to hold it firm, while it is severed from the ground with the incisors of the lower jaw, with a twitch of the head to one side, notwithstanding the want of teeth in the upper one; whereas the ox is better suited to the plains and valleys, where grass grows long, and may be cropped by the scythe-like operation of its tongue and teeth. The practical conclusion to be drawn from these different modes of cropping grass by the domesticated animals is, that the horse or sheep should follow the ox in grazing, or accompany him, but not precede him. When they follow, the pasture will be eaten barer by the horse or sheep than the ox left it; and, when in company, it will be eaten barer by the horse or sheep where the ox has eaten before, or it may first be topped by the horse before the ox has touched it. Whether the horse or sheep should follow or accompany the ox, the latter is the preferable arrangement, because they have then the choice of the long grass, as well as the short. The same reason that should graze the horse and sheep, in reference to the ox, should cause the horse to be separated from the sheep, particularly in the latter part of the pasture season, as both biting close make the grass too bare for either. Horses, too, and work-horses in particular, have a greater dislike to sheep than to cattle.

3774. An inconvenience at times attends the grazing of all kinds of stock on a farm of mixed husbandry—that, as in every summer the same number of stock exists, there may not be the same quantity of grass to support them; as the same number of acres, secured by a regular rotation of crops, may produce different quantities of grass in different seasons—one year affording a scanty, another a superabundant supply. The number of stock should correspond with the produce of an average year. A bad year may much stint the condition, while a good one may grow more than the same stock can consume. The stinted condition cannot be amended by the sale of any of the stock, as it is impolitic to disturb the equilibrium of the ages and kinds of the stock existing on the farm; and a general sale of stock, under the circumstances assumed, would lower their value; and if the stock suffer hunger, as it did in the severe drought of the summer of 1826, no alternative exists but to make up the deficiency by hay, even though it should be purchased for the occasion. On the other hand, superabundance of pasture does no harm; for, independent of its maintaining the entire stock in high condition, the rough aftermath will be of great service to the ewes in winter. On farms the stock of which are purchased every year, the number may be regulated by the crop of the grass; but even in that case the season may turn out worse than expected. Seeing that no one can foretell the future state of the grass, the prudent plan is, in every case, to keep the number of stock under the mark which the farm can support.

3775. An essential requisite in all pasture-fields is an abundant supply of *water* for the cattle to drink. Both cattle and horses drink largely, and sheep, grazing early on the dewy grass, do not require so much water to keep them in a healthy condition; still, when no dew falls, and drought continues, they drink a little water. The proper construction of a watering-pool is sadly misunderstood in this country. The entrance to it generally is a puddle of poached mud at least half a foot in depth, to avoid standing in which the animals go into the water, and render it muddy before they drink. Not unfrequently the pool becomes nearly dry from

scarcity of water, and the little left becomes almost stagnant. The objections to such a mode of supplying so necessary and wholesome a beverage to animals as water, are obvious, and a thorough amendment of the present system is requisite on almost every farm. A rivulet runs through some part of most farms, and tanks of wood or of stone are provided in fields, in connexion with an adjoining spring, or with a pump-well, where no rivulet runs; but no means are used to provide a reservoir of water on streams which are apt to become dry in most summers, and in such cases cattle are worse off than with pump-wells—though too often the water is forgotten to be pumped out of them every day, and at best they cannot provide all the requisites of a good watering-pool. For in hot days a walk into a clean pool is wholesome to cattle, and in very dry weather a stand at a time amongst water is an excellent preventive of that troublesome complaint, the foot-sore. The external application of water in this manner allays inflammation, and prevents irritation, and permits the animals to take their food in peace in a scorching drought. The water out of a tank of a pump-well is never relished by cattle, and in cold and rainy weather it is rarely visited by them; and in hot weather, it is viewed with indifference, because it is evidently inadequate to supply all their wants for water; and tanks are invariably placed too high for sheep. A watering-pool should be roomy and securely fenced, as cattle are apt to push one another about while in it, and several go together to drink or stand in the water; and it is the same practice with young colts. It should be of considerable length and narrow, to give access to it for a number of the cattle at the same time; and its side next the field should be made hard with broken stones like road metal, the bottom of the pool gravelled to keep the water clean and sweet, while the water should always flow gently through it.

3776. Where water is so scarce, that no rivulet runs through the fields, and no water can be obtained by the sinking of wells, the only expedient is to bring water to the pasture fields from a distance in barrels mounted on wheels, such as the liquid-manure barrel in fig. 194. Such a barrel may be filled at a pump, or more

likely at a rivulet at some distance; in which latter case it has to be filled with such a scoop as is represented in fig. 311, of the dimensions, and used in the manner described in (2075.)

Fig. 311.



THE SCOOP FOR FILLING THE WATER-BARREL.

3777. The want of sheds in pasture-fields is also a sad reflection on the sagacity of our farmers. In summer, where a tree spreads its branches over the grass in a lawn, how gratefully cattle resort to the shade, where they know that the stirring breeze will cool their hides, and afford them a refuge from the attacks of flies. In cold weather, cattle crowd to the wooded corner of a field, and will do so in a rainy day even in summer. Such indications by animals teach us how they ought to be treated. I am no advocate for hedgerow trees, although they should cast a grateful shade into a pasture-field, since they prove injurious to the crops and fences near them; and still less do I admire an umbrageous plane in the middle of a field devoted to a course of cropping; but similar effects may be obtained by other means. There are few farms one or two sides of the fields of which are not sheltered from some quarter by a few trees; but, independently of this, a shed, erected at a suitable part in the line of the fence, would not only afford a shade in the hottest day in summer, but shelter in a rainy day, or in a cold night in autumn. Such an erection would cost little where stone and wood are plentiful on an estate, and they should be placed to answer the field on either side of the fence when it is in grass. But no matter what it costs, when the health and comfort of stock are concerned. Its cost would be repaid by the state of the stock in the first year of its erection, and it would stand, with slight repairs, for a long lease. Let it be roomy, and its structure light, and it may be roofed at a moderate cost with zinc, or composition, or tiles, when manufactured in the neighbourhood. It may be troublesome to carry straw for litter from the steading to a shed situate at a distance; but there is little occasion

for straw in summer, as the rough grass from an adjoining wood, or a ditch, will supply litter; and the dung, at all events, should be shovelled up and removed before it accumulates to the discomfort of the animals. I should like to see every farm systematically furnished with such sheds, to the extent at least of one shed every two adjoining fields.

3778. Young cattle are not grazed on *carse* farms, nor on farms in the neighbourhood of towns. On the former no land is appropriated to grazing, as the grass is kept for only one year, and it is chiefly used for forage and hay; and on the latter it is more profitable to sell the grass for forage, and make hay. The grazing on these farms is confined to the farm milk-cows and work-horses.

3779. On *dairy* farms the pasture for cows is preferred on old lea abounding in natural grasses, which afford finer flavoured butter and richer cheese than young grass. On such farms cows are kept for the express purpose of yielding dairy produce, forming the principal stock, and receiving the largest share of attention. They are brought into the byre at night, milked there morning and evening, and generally only twice a-day. It is most profitable for the dairy-farmer to give his cows at all times as much food as they can consume; and with this view, besides the fine pasture during the day, they have clover-grass or tares in the evening for supper.

3780. The most profitable and also convenient plan for dairymen in towns is to keep their cows constantly in the byre in summer, and to feed them on forage, and purchase such litter as can be found cheapest at the season. In pursuance of this system, the irrigated meadows in the neighbourhood of Edinburgh are taken by the dairymen by auction every year, and their produce cut and carted daily from April to November. The number of cuttings may be 4 or 5 in that period. The usual rent is from £16 to £20 the acre; and in the excessively dry year of 1826, such was the demand for the grass which grew well, while the forage plants of the arable fields were burnt up, that the rent was £40 the acre. But such is the conviction of the healthy nature of pasturage for milk cows, that many dairymen in towns take pasture at high rents in the neighbourhood, and allow the cows to lie out all night, and incur the trouble and expense of sending people to milk them twice and thrice a-day.

3781. On *pastoral* farms devoted exclusively to the rearing of *cattle*, the calves are allowed to go with their dams, from whom they draw as much milk as they can get, and support themselves besides on grass. The calves thrive well in this way, and attain to a large size; and could the farm maintain them in the same condition until 3 years old, they would become very fine beasts. But, unfortunately, they fall off in condition

whenever they are weaned in autumn, and it is difficult to bring them up to the same condition in winter. This circumstance raises a doubt in my mind whether it would not be better to wean the calves at 4 months old, and let them depend entirely on the grass in the best season of the pasture, and no difficulty would then be felt of maintaining, in the ensuing winter, the growing and healthy condition thus attained. Such a plan would no doubt incur the trouble of milking the cows, as it would be improper to let them run dry in the height of the grass season; which, besides incurring the loss of milk, would be impolitic to pursue, as it would put the cows in so high a condition before winter, as would be difficult to be maintained until next calving. Cows with calves at their foot will wander long distances from home if their range of pasture is large, and they evince great art in concealing themselves and their calves.

3782. The young stock on pastoral farms graze on the lower and more sheltered portions of the grazing, till the weather becomes less stormy and cold in the upper parts, when they stretch their walks upwards by degrees until the highest points are at length attained. This procedure cannot be strictly adhered to where no fences mark the boundaries of the farm; but in the higher elevations the state of vegetation naturally deters them from proceeding higher up until the grass grows. It would be better were fences laid off to divide the pasture into portions, which should be occupied during the season at proper intervals of time; and it has often occurred to me, that this object would be best attained were fences to be run in horizontal parallels along the face of a height, or round an entire hill, than up and down the slope of the ground. As it is, pastoral farmers seem contented with a ring fence round their farms. It is the duty of the herds to ascertain the state of the cattle every day.

3783. Young cattle are purchased for farms in the arable districts of the country, on which none are bred, immediately before the grass is ready to receive them; and not unfrequently this class of farmers hire grass-parks for the season and stock them with young cattle on speculation. Such cattle are obtained at public markets, or from breeders who do not keep their stock beyond two years. Young cattle for grazing should have all the symptoms of health, a clear eye, dewy nose, and glossy long hair, although they may be in low condition. Such a condition may be a greater loss to the breeder who has half starved them, than to the purchaser who may have good pasture to give them on sound feeding land. To attain full size they should have a strong bone, and their appearance might be termed *raw-boned*;—that is, the skeleton seems large in proportion to the quantity of flesh, and implies a quick growing condition. To be a good thriver and attain condition, the hair should feel mossy, and the touch of the skin mellow. The skin should not be too thin, nor feel hard and tight, and it should be covered with abundance of hair. A thick tail with plenty of hair on it and at the point, indicates strength of back

and constitution. The hams should not be too full of flesh, *lyary*, (3622,) which in a young animal indicates that the carcass will soon set from growing. A deep body, and short carcass between the shoulder-blade and the hook-bones across the ribs, indicate a disposition to fatten at a small size. Flat ribs and a high back-bone indicate difficulty of fattening; and though the bone of the legs may be large enough, it is coarse and round, instead of flat and fine; and the sinews seem indistinctly marked and heavy, instead of small and clean. On selecting a lot of young cattle, they should all nearly be of the same size and appearance; and they will then be what is termed *level*, presenting an even surface over their backs when standing together, or walking in a drove—the sharp horns and ears of the horned cattle, and the crowns of the heads and ears of the polled ones, rising above the level of the backs. This levelness is a very enticing property in every lot of cattle. It is a lesson to the seller in preparing cattle for the market, to assort them in lots of equal levelness, and the larger the level lot is, the more is the purchaser persuaded that pains have been taken in their breeding. When a number of cattle of the same breed have to be compared, the properties which distinguish the particular breed must form the standard of comparison, and what those standards are you shall know when we come to treat of the properties of the different breeds.

3784. As to the state of cattle most profitable for the farmer to purchase, I believe that 2-year-old queys have been found the most kindly feeders in every breed. They are subject to periodic disturbance when in season in summer, and to avoid these the operation of spaying (2287,) was recommended, and was at one time extensively practised; and as long as the heifers generally possessed few properties for becoming good cows, the practice was unobjectionable. Now, however, that every farmer possesses a large proportion of his heifers well formed, spaying has fallen into desuetude, and it is found more profitable to dispose of them as breeding stock than to fatten them, and the heifer market is not now so well supplied as it used to be. Good 2-year-old queys, from upland pastoral farms, can seldom be obtained without being in calf, the bulls having the range of the pastures. Of the different breeds, perhaps, more heifers may be obtained of short-horns for feeding, than of any other; and the reason is, that this breed is now so generally improved, every animal possessing good properties, that all cannot be transferred to the cow stock, and are therefore brought to the market for other purposes, if desired by purchasers. I have known, even lately, handsome profits returned from those heifers, when no such profit could be obtained from steers of any kind. Still, as every farmer cannot be supplied with heifers, oxen must be purchased in lieu; and the age at which these should be purchased depends upon the nature of the soil. Some soils bear pasture which will fatten oxen of large size, and on these steers of 3-years will return most profit; on weaker soils, it would be folly to attempt to feed cattle to heavy weights; and for

light soils, young beasts should always be chosen. Of the black breeds, the hornless Angus and Galloways, the West Highlanders and Aberdeenshires, or a cross of all these with short-horn bulls, are kindly feeders. Those who possess pasture that will feed a heavy ox have the advantage, as they can purchase small stock as well as large; but those who have only weak land must purchase small, and, for most profit, young stock, and let the heavier and aged alone to others.

3785. The following observations of M. Boussingault, on pasturage in general, and on the effects produced by pasture grass on the size and condition of cattle in several countries on the Continent, are interesting. "In those countries," he observes, "the nature of whose climate is favourable to pasturage, the rearing of cattle presents immense advantages, but the animals can only be fattened in those that are the most fertile. The meadow that suffices for the growth and keep of a bullock, will not always bring the animal into condition for the butcher. Those countries where the climate is moist, and long droughts rarely felt—where neither the summer heats nor winter colds are excessive—the conditions in fact, which are met with in the beautiful pasture lands of England in especial, are those that prove most favourable to the rearing and feeding of cattle. The pasture lands of Normandy and Brittany in France, of Switzerland, Holland, several of the provinces watered by the Rhine, &c., are also remarkable for their luxuriant herbage. In such situations, and with such advantages, the grand object of the farmer is the production and fattening of cattle.

3786. "Wherever it has been possible to lay down extensive and productive meadows, it is now beginning to be clearly understood that the introduction of even the best system of rotation were to make a false application of agricultural science. In my opinion, there is no system of rotation, however well conceived and carried out, which will stand comparison, in point of productiveness, with a natural meadow, favourably situated and properly attended to. The reason of this is obvious, and follows from the very principles which we have laid down in treating of rotations. The whole object in the best system of husbandry, is to make the earth produce the largest possibility of organic matter in a given time. But in such a system we are limited by the climate, inasmuch as we are obliged so to arrange matters that our crops shall always attain to complete maturity; the consequence of which is, that with all our pains the soil remains unproductive during a certain number of weeks and months towards the end of autumn, in the early spring, and through the whole of winter. But upon meadow lands vegetation is incessant; the winter, even, does not interrupt it completely; it still revives and makes progress in the bright days; and in spring it proceeds when the mean temperature is but a few degrees above the freezing point of water, and never ceases until it is checked again by the severer cold of winter. It is therefore easy to obtain conviction that a given surface of meadow land must

necessarily produce a larger quantity of forage than land laid out in any other way. It is true that the forage thus obtained will not, like the cereal grasses, answer immediately for the support of man; but it nevertheless concurs powerfully in this by producing milk, and butter, and cheese, and in breeding and fattening cattle. Let there be added to all these advantages of what may be called a permanent vegetation, that the cost of keeping it in order is infinitely less, and that there is no risk to be run from failures of crops, and the vast advantages of meadow or pasture land will meet us with all their force."

3787. These preliminary observations of M. Boussingault suggest a few remarks on the propriety of having some meadow land, as he and the farmers in England name what in Scotland is called permanent pasture, on every arable farm; and were those observations absolutely applicable to all situations, they would go far to sanction the practice which prevails in England, of having a large proportion of the country in meadow, whether the soil be really fitted to grow permanent pasture. However well suited the climate of England may be for the growth of meadow grass, there is no question that much of the land of England is kept in meadow which is unsuited for it; for that soil is certainly not suitable which grows coarse rank herbage, equally unfit for good pasture and hay, and which is more occupied with rushes than any other sort of plants. Whatever use such soils may be after being drained, and worked, and made to grow fine plants, they are in their present state unfit to be meadow land.

3788. The practice of Scotland encourages the opposite extreme of having no meadow at all, on land which the plough can make arable, and the practice may have taken the strong root it has as a consequence of the general poverty of the soil, which imposes the conviction that no naturally poor soil is capable of growing good permanent pasture. Permanent grass of some kind is no doubt grown on many places in Scotland, but unless such pasture is capable of being converted into hay or pasture, as the farmer pleases, it is not entitled to the character of a permanent pasture that will fatten stock.

3789. It was once a great desire of the Berwickshire, as it still is of the Northumberland farmer, to have at least one field on the farm of good permanent pasture, and the best land was chosen to be converted to such a purpose. Experience had proved that large oxen would not feed ripe but on old grass, and the farmer who desired to feed oxen of extraordinary weight could not accomplish his end unless he had pasture in summer for his beasts that would feed to a great weight. But after it was found to be more profitable to feed cattle fat at as early an age as practicable, and which can be easily accomplished on turnips and sown grasses, with the assistance of oil-cake and linseed meal, the old permanent pasture was no longer required, in as far as the fattening of heavy oxen was concerned; and the consequence was, that much of it was plough-

ed up and thrown into the ordinary rotation of the farm. Still old grass has one use which the extension of new has not yet provided—it formed the rankest and thickest pasture in autumn, long after that from the sown grasses had ceased to grow and become bare. This inconvenience attending the sown grasses, has partly been met by pasturing them after the grain crop has been removed in autumn, and partly by the extension and early production of the turnip. An old lea is an excellent winter walk for ewes in lamb, and a few turnips strewed upon it are kept clean in the worst weather.

3790. In relating the mode of pasturage followed in some of the countries of Europe, M. Boussingault goes on to say, that “on the banks of the Rhine, in Holland, in the neighbourhood of Arieheim, the meadows are depastured during one year, and cut, and their produce made into hay the following year, and so on alternately. The cattle are fed in the house with the hay during the winter. They are driven out into the pasture in May. In the Low Countries, it has been found that to fatten a large ox, a surface of meadow land, of about 9960 square yards, (more than two acres,) upon which it will pasture during five or six months, was necessary. In the bottoms of greatest fertility near Dusseldorf, it has been calculated that to keep a cow, an extent of surface equal to about 1800 square yards ($1\frac{1}{2}$ rood) was necessary.

3791. “In countries which possess rich pasture lands, oxen are put to fatten immediately upon the richest of them. In the valley of the Auge, in Normandy, these meadows are designated as herbage. A meadow of this kind requires a rich damp soil, capable of retaining moisture. It is, therefore, to a considerable extent dependent upon its subsoil. In the district mentioned, the soil of the pastures consists of a thick layer of vegetable mould, resting upon clay; it is, therefore, very rare that this meadow land feels the effect of drought; it is, indeed, only in the early spring that the pasture upon such land sometimes fails, in which case the stock must of course be assisted with hay, the quantity being gradually diminished as the season advances.

3792. “M. Dubois finds that a lean ox, weighing 473 lb., after fattening in the valley of the Auge, will weigh 763 lb., so that he will have gained 290 lb., (or 1 lb. 3 oz. a-day, in eight months, or 1 lb. 6 oz. a-day in seven months.) The degree of fatness attained in this district is prodigious. M. Dubois mentions oxen which weighed when fat 1760 lb., upwards of 125 stones; and he speaks of one which attained the enormous weight of 2750 lb., upwards of 196 stones.

3793. “It is calculated that, in the meadows of greatest fertility, a surface of 2760 square yards, (more than half an acre,) are required to fatten a large ox. On meadows of medium fertility, a surface of 4680 square yards (nearly an acre) are

required to fatten an ox of medium size. On those of the third quality, a surface of 3720 square yards, (about three roods,) is deemed necessary to fatten a small ox.

3794. “M. Dubois calculates the quantity of grass fodder consumed by an ox during the eight months when he is fattening, as equivalent to 6600 lb. of dry hay, (equal to 300 stones, of 22 lb. to the stone;) this is at least the quantity that the extent of meadow required to fatten one ox would produce: The average ration of green forage each day is, therefore, equivalent to about 27 lb. of hay, a quantity which appears small, and which would be so in effect, were not the oxen kept so long in the meadows. M. Dubois, indeed, observes, that in the stall, with a ration composed of from 11 lb. to 13 lb. of linseed oil-cake, and 26 lb. of hay, an ox will become sufficiently fat for the butcher in 70 days, and will acquire nearly the same weight that he would have gained in the course of seven or eight months in the meadows. There is nothing surprising in this fact, inasmuch as the ration mentioned by M. Dubois, in our mode of viewing it, is equivalent in nutritive value to at least 81 lb. weight of hay; the quantity of oil-cake alone is enough to supply a good pound weight of fat a-day.

3795. “In Old Friesland, where the pastures are excellent, results are obtained which may be compared with those of the meadows in the valley of the Auge; an ox of from 770 lb. to 990 lb. weight, (about 70 stone,) will be pushed to a weight of from 1100 lb. to 1650 lb., (about 118 stone,) on a surface of meadow land between 3000 and 3600 square yards (nearly 3 roods) in extent.

3796. “In the meadows of the Auge, the fattening goes on even during the winter; the oxen are received into the pastures between the 15th of September and the 15th of November, and the animals pass the winter in the open field; but they receive from 12 lb. to 26 lb. of hay a-day until the month of April, when the grass has already grown sufficiently to suffice for their keep. These oxen are generally fat and ready for the market in July.”*

3797. I am not aware of any experiments having been purposely undertaken, in this country, to ascertain the increase of flesh by oxen during the grazing season. Fattening cattle are not kept above five months on grass, from the end of May to the end of October, or 153 days. Sir John Sinclair mentions that Galloway cattle, when kept in winter so as to maintain the condition they had acquired on the pasture of the previous summer, put on all their increased weight on the grass alone, and this increase varies with the age of the cattle: those from 3 to $3\frac{1}{2}$ years old, increase 11 stones; and those from 4 to $4\frac{1}{2}$ years old, increase 13 stones. He adds, “Almost all these several additions are gained, according to the Galloway report, during

* Boussingault's *Rural Economy*—Law's translation, p. 619-21.

the six months of the grass season." I take the grass season at five months; and at the above increased weights, the younger ox gained just 1 lb. a-day, and the older one 1 lb. 3 oz. a-day on pasture, which agrees pretty near with the results stated by M. Dubois, as having been obtained in the pastures of the valley of the Auge (3792.)*

3798. Cattle are subject to *very few diseases while upon grass in summer*. Sometimes they receive a chill in a sudden change of the weather to wet and cold; but were sheds provided in every field, probably no chills would be felt, as cattle never suffer from cold when they have shelter at will. The immediate effects of such a chill is a staring coat and hide-bound skin, which may be removed by a cordial drink, composed of one quart of gruel and one bottle of ale in a lukewarm state, in which has been dissolved some treacle, and spiced with 1 oz. of ginger and 1 oz. of caraway seeds ground fine. The drink is administered with the drinking-horn (1481) and the animal kept in a shed for a night or two. The ultimate danger from such a chill is inflammation of the lungs, which in most cases is a fatal disease.

3799. The teats and udder of cows are at times subject to certain complaints in summer; and these are *chapped teats, sore teats, warty teats, and cow-pox*. Chapped teats consist of cracks across the teats, which, when drawn downwards, the cracks are forcibly opened, and inflict pain on the animal, which then becomes troublesome to milk. The easiest mode of milking them while under this complaint, is that described by nievling in (2258.) while stripping aggravates the complaint (2257.) I do not know the certain cause of this complaint, but suppose it to arise from leaving the teats in a wet state after milking; and perhaps cows lying upon wet ground may have the same effect.

3800. Sore teats are, when blotches of skin come off the teats, and their fleshy substance becomes sore by exposure to the air. This complaint may arise from the milker who strips seizing a particular part of the teat too hard, where an inflammation being set up, terminates in a sloughing of the skin, and consequent exposure of the fleshy substance to the air.

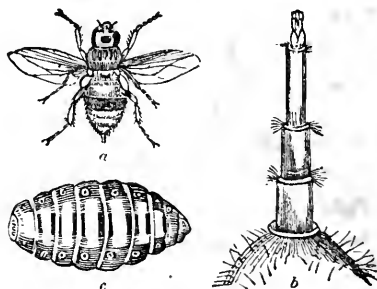
3801. Warty teats, I conceive, may originate in the skin of the teats being ruffled by too much force in stripping, or by too long a nail upon the thumb; and the warts produced in consequence may be exuberances of the skin in covering the injured parts. I am not sure that these conjectures, for they are nothing more, will explain the causes of these complaints; but I believe when care is used not to abrade the skin or pinch the substance of the teats, but to keep them clean and dry, none of them ever occur.

3802. As to the cow-pox, it is a constitutional disease, and cannot be either induced or retarded.

The pock makes its appearance both on the udder and the teats of the cow; and as milking must be performed frequently by all the teats, the operation is very painful to the cow, and she becomes troublesome to milk. The pustules are soon rubbed off by the operation, and their sites become skinless sores. Nothing but the utmost gentleness will prevent the cow becoming distracted under the torture. After having run its course, the disease declines, the sores become less acute, and heal up by degrees. The disease fortunately is not of frequent occurrence; I have only seen it once in the course of a fifteen years' experience, and it affected all the cows I had at the time—9 in number. I found an efficacious ointment in affording relief to the cows when afflicted with the cow-pox, sore teats, or chapped teats. It consists of fresh butter melted and burnt in a frying-pan, and mixed with half its quantity of tar. While hot it is poured into a gallipot, and applied cold to the affected parts. The tar has the effect of keeping off the flies, while the burnt butter never becomes dry. The ointment is washed off with warm water, and the udder and teats dried with a soft linen cloth, before milking commences; they are again bathed with warm water after milking, again dried with the soft linen cloth, and the ointment again applied.

3803. *Warbles*.—Cattle are not unfrequently troubled, towards the latter end of the feeding season, with what are named *warbles* or *worms*, that is, small swelled protuberances along the chine, caused by the larvæ of the (*Estrus bovis*, the cattle-bot. Fig. 312, a, gives a representation

Fig. 312.



THE CATTLE-BOT AND LARVA—ESTRUS BOVIS.

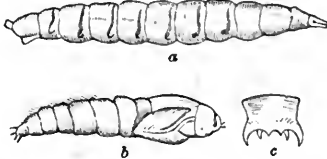
of the fly which originates these larvæ. It is the female, which has the abdomen attenuated behind, and terminating in a black-coloured style, composed of cylinders which slide into each other like the tubes of a telescope, as seen at *b*, but greatly magnified. It is not well ascertained whether the fly merely lays her eggs on the hair or skin, and the larva, when disclosed, is left to force its own way beneath it, or a perforation is made by the fly and the egg deposited with it. That the latter is the case seems most probable, as the ovipositor *b* seems constructed

* Sinclair's *General Report of Scotland*, vol. iii. p. 90.

for the express purpose. Cattle feel great pain, and become almost furious, when attacked by this fly. The larvæ are of an oblong shape; the body divided into 11 segments by transverse bands, which again are crossed at the sides by longitudinal lines; and on each side of all the segments there is a distinct spiracle or breathing-hole. The young larva is found to occupy a small cyst or cell within the substance of the skin, which gradually enlarges with its growth; while the pus, which is abundantly secreted by the irritation, serves for its subsistence. "The tumour is never entirely closed around it," says Mr Duncan, "there being always a small aperture on the upper side. On attaining its full growth, the larva makes its exit by the aperture just mentioned, and the wound speedily closes up and is healed; but the hide never recovers its original strength, as afterwards appears when it comes under the operations of the tanner. It is remarked by Reaumur as a singular circumstance, that the larva commonly issues from the tumour, to assume the pupa state, at a very early hour in the morning, and thereby avoids many of the dangers to which it would be otherwise exposed. The warbles are so conspicuous on cattle, that if searched for scarcely any could be overlooked; and they may be killed with the utmost ease by simple pressure of the finger and thumb, or by pouring some corrosive liquid into the aperture of the tumour. They are seldom so numerous but that a short time would suffice to inspect a whole herd, and if this were done simultaneously at different places, an entire district might in a short time be nearly or altogether freed from this pest.*"

3804. A very tormenting insect to cattle on the Highland moors, though it is scarce in the lowlands of Scotland, and far from being rare in England, is the cattle cleg, *Tabanus bovinus*. It is about one inch in length, being the most bulky of our native Diptera. When the proboscis is fixed in the skin, and employed in pumping the blood, the insect can in general be easily got at, and killed with a stroke of the hand. The instrument by which the skin is pierced, and the blood extracted, is of curious and complicated structure. The larva *a*, fig. 313, is long and cylin-

Fig. 313.

LARVA AND PUPA OF THE CATTLE CLEG—*TABANUS BOVINUS*.

dricular, narrowing at the head into an elongated cone. The body is divided into 12 rings, the anal one being very minute, and resembling a spiracle; colour dirty white, the head brown and shining. The pupa *b*, is nearly cylindrical, of a

greyish-brown colour, the segments fringed on the posterior margins with grey hairs. The anal segment is small, and armed with 6 sharp scaly points *c*, which seem to enable the pupa to push its head above the surface of the skin.†

3805. *Pleuro-pneumonia*.—Epidemic zootic diseases have more or less frequently ravaged the cattle of many countries from the earliest period of history. During the past century, they have made havoc in several of the countries of Europe, especially in the pastoral plains of the Ukraine; and of late years—only since the permission to import live stock—they have crossed the ocean that begirts our island, and have visited our establishments of stock with fearful severity. None of the epidemics have been so direful in their effects as what was formerly denominated epidemic catarrh, then murrain, and now pleuro-pneumonia. From the earliest accounts of this disease, we find the predisposing cause attributed to marshy and woody districts, or where perfect under-draining did not exist, combined with exposure to sudden changes of the atmosphere, and a half-starved method of feeding. The influence of these predisposing causes is now acknowledged by agriculturists and veterinarians; but, however ill-ventilated byres, want of drainage, dirt, and nastiness of every description, may aggravate the force of the disease when it exists, these cannot be said to be the predisposing causes, since they all existed in their full strength, and in the same places, before the disease was so well known. Where are ill-ventilated byres to be found in the Ukraine, the cradle of the disease? The truth is, the complaint is found in this country in the best managed and best constructed dairy-houses of the country, as well as in the worst; and since this is the case, we must look to more general influences than those to be found in locally ill-constructed houses, for the origin of the disease; especially as exposure to cold, with bad food, and little of it, are in themselves quite sufficient to originate an affection of the lungs, which pleuro-pneumonia is, and nothing more; and which can be cured as certainly as anything can be so, provided its approach is detected, and remedial measures applied in proper time.

3806. The functional vessels of the lungs, as remarked by Dr James Mercer, are three in number: the air vessels—the pulmonic vascular substance, the parenchyma—and the investing serous membrane, the pleura. All these vessels are subject to inflammation.

3807. The inflammation of the mucous lining of the bronchial tubes and air cells, is called *bronchitis*; that of the pulmonic vascular substance, or the parenchyma of the lung, is called *pneumonia*; and that of the investing serous membrane of the lung is called *pleurisy*, or inflammation of the chest. *Pleuro-pneumonia*, is, therefore, inflammation of the vascular substance and of the investing serous membrane of the lung, com-

* *Quarterly Journal of Agriculture*, vol. x. p. 544.† *Magazine of Zoology and Botany*, vol. i. p. 359.

bined—a combination attended with great danger to, and even rapid destruction of life.

3808. The symptoms of these three species of inflammation are shortly the following:—Of bronchitis, breathing quick and free; cough at first short and soft, then loud, harsh, rough, and prolonged; pulse, frequent, but full and soft. Of pneumonia, breathing weaker, slower, stifled; cough, short and stifled; pulse, small, weak, and oppressed. Of pleurisy, breathing short, and only partial; cough, short and catching; pulse, rapid, hard, and wiry. As long as the symptoms indicate only bronchitis, a cure may be easily effected; but if neglected, and allowed to run into pneumonia, danger becomes imminent, and rapidly passes into pleurisy, when death ensues.

3809. In every sort of inflammation of the lungs, there are three stages—congestion, red hepatisation, and gray or white hepatisation. In congestion are found engorgement and pure inflammation. In red hepatisation is no circulation of air, no crepitation. In gray hepatisation, lymph is effused throughout the substance of the lungs, which are marked with black patches, caused by the colouring matter of the blood being imprisoned in the vessels. In this last case, recovery is hopeless.

3810. Cases of pleuro-pneumonia, which assume the distinct forms either of pneumonia, pleurisy, or bronchitis, will generally terminate favourably, while those characterised by prostration of strength and typhoid fever, will be much more difficult of treatment, and often terminate fatally. Where animals are exposed to E. winds and drizzling rains, the symptoms seem to approach nearer to those characterising *pure* pneumonia; while, on the other hand, dry, cold weather, and sharp, severe winds, cause the symptoms of pleurisy to become more apparent.

3811. Young animals seem less predisposed to pleuro-pneumonia than such as are nearer maturity; and fat cattle are attacked less frequently than those in a backward condition. But of all sorts of stock milk-cows are the most liable to this disease.

3812. Much difference of opinion exists concerning the propriety of using the flesh or milk of animals affected with pleuro-pneumonia. In the first stages of the disease, before the inflammatory fever has run its course, both the flesh and milk may safely be used, but not so when the fever has assumed a typhoid form.

3813. Whenever the disease appears characterised by the earliest symptoms, decided treatment must be had recourse to. Bleed at once, and carry it to such an extent as to make a decided impression on the circulation. If this is effected, and the symptoms become moderated, the bleeding must *not* again be repeated, as irre-

mediable debility would rapidly follow. Promiscuous bleeding must be avoided; for, without careful analysis of the symptoms, bleeding will hasten the fatal debility of the system. After the bleeding give a purge of 1 lb. of Epsom salts 1 drachm of tartar emetic, and 2 or 3 drachms of ginger, mixed in water; and the dose should be repeated every five or six hours, until purgation has been produced. When this has been accomplished, let an anodyne diaphoretic mixture be given regularly, at stated intervals of four or five hours, consisting of half an ounce of laudanum, 2 drachms of tartar emetic, and 2 pints of water, and thereby keep up the diaphoretic or sweating effect. The animal should be carefully removed from its companions, into a clean, comfortable loose-box, or outhouse, free from sudden changes of the atmosphere. Cover the body with a warm woollen rug to prevent the too rapid evaporation of the sweat, which would chill the animal. Warm bran mash, and tepid meal and water should be left beside it, and a little of any slightly stimulating food that may be at hand. Should symptoms of debility remain, tonics are required, beginning with camomile tea, and giving stronger ones as the strength increases, as the infusions of gentian, columba, cascarella, &c.*

3814. “The grand principles which ought to regulate our treatment of pleuro-pneumonia, and which, when properly pursued, will guide us to the best and most scientific mode of combating the disease, may be thus set forth in a few words,” observes Mr Finlay Dun, veterinary surgeon. “Pursue warily the antiphlogistic course; subdue the inflammation, and reduce the fever, with the least possible expenditure of the strength of the patient; resort to venesection only when the symptoms indicate a state of active inflammation; avoid pushing too far the exhibition of sedatives, contra-stimulants, or any depleting measures whatsoever; rely mostly on the use of tonics, and subsequently of stimulants; separate the animal from his fellows—place him, if possible, in a loose box, and keep him cool, clean, and comfortable; keep the bowels in good condition with treacle given at intervals; check the slightest appearance of diarrhœa by giving flour gruel, and, if necessary, astringents. Where the animal is reduced, and manifests much weakness, blisters, rowels, and setons are to be condemned, as producing irritation and increasing the hectic fever. In short, let the treatment of the disease be guided by a mature consideration of the symptoms; and, while attending to the more important remedial measures, do not neglect what is aptly called by Dr Armstrong ‘the small artillery of physic;’ endeavour, by the combination and co-operation of various means, to arrive at the main point—the grand object of your treatment—the eradication of disease and the restoration of health.”†

3815. In summer, “inflammation of the larynx frequently takes place in cattle, the disease, at

* *Journal of Agriculture* for March 1848, p. 313-16.

† *Transactions of the Highland and Agricultural Society*, for July 1849, p. 64.

the same time, spreading from the delicate lining membrane to the nearest parts. In this way lymph is effused, and the play of the parts impeded. Sometimes the smaller cartilages themselves are altered, being thickened and contorted, and small tumours are apt to be produced, both within the tube and without it. The marked symptoms are local pain, difficulty in breathing and swallowing, and general fever: the treatment required is venesection, and the other parts of the antiphlogistic regimen.

3816. "Tumours occurring in this locality in cattle constitute the disease called *clyers*, which, though it may not for a time interfere with fattening, yet speedily injures health."*

ON THE TREATMENT OF BULLS IN SUMMER.

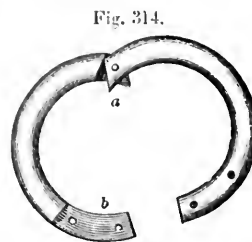
3817. *Bull-calves*, we have said, (2290,) should be early calved, have good milk every day, for at least four months, to strengthen their bone, and until the grass is quite able to support them, and to maintain the fine condition they have acquired on the milk. If the mothers of the bull-calves did not afford sufficient milk for them, it was the practice of that very eminent breeder, the late Mr Robertson of Ladykirk, in Berwickshire, to have cows in milk to supply the deficiency.

3818. When a number of bull-calves are brought up together, they should be grazed by themselves on the best grass the farm affords, or they may go with the cows, or with the ox-calves while the quey-calves go with the cows. Anyhow they should not be allowed to accompany the quey-calves. I knew an instance of a quey calf being stinted at as early an age as to bear a calf at 15 months old; and I knew another quey-calf, one of my own, that was so injured by a young bull-calf, that she was thereafter rendered incapable of impregnation, although her season recurred periodically. To avoid such casualties, it is well to keep young animals of different sexes, capable of breeding, apart. A single bull-calf may go with the cows or with the young oxen.

3819. Year-old bulls should be furnished with a *ring* in their nose. This instrument is, useful not only in leading them, but of keeping their temper in subjection. I have no doubt that such a ring affords a

more complete command than anything else over the most ungovernable bull. In case a bull becomes irritative and troublesome as he advances in years, which is often the case, the ring furnishes the means of curbing him at once, when it would otherwise be impossible to get a hold of his nose. It also affords an easy means of suspending a light chain from it to the ground, upon which the fore-feet of the bull are apt to tramp, whenever he attempts to run forward, and by thus suddenly jerking his nose, he checks himself in an instant. A young bull may follow a person in sport, and then run at him in earnest. I was once encountered by a 2-year-old in the midst of a pasture field. Feeling it vain to reach a fence before he could run at me, I determined on standing still to face him, armed with a couple of large stones. When he came within five yards of me, scraping the ground with his fore-feet, with his head close to the ground, and bellowing with apparent anger, I struck him a blow with a stone on the forehead, between the horns, on which he started up, became silent, shook his head, turned, and ran away in a trot. Not content with defeating him in this manner, he was taken to the steading, and a new rope fastened to the ring. I led him to the highroad, and punished him so by checking him by the nose, that he never again attempted to meddle with any one. To keep him in constant check, a chain was suspended from the ring, with its end trailing on the ground.

3820. Fig. 314 represents a bull's ring. It consists of two semicircles constituting



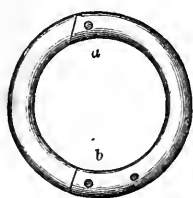
THE BULL'S RING IN A STATE TO BE INSERTED IN HIS NOSE.

Fig. 314. a circle or ring, joined together at one end *a*, with a rivet passed through the endslapping over each other, after each end is reduced to half the thickness of the ring, and acting as a hinge; and the other two ends *b* also lap, and are fastened together with two countersunk screws. The ring is opened, as

shown in the figure, before it is passed through the hole in the bull's nose.

3821. Fig. 315 shows the ring screwed together as it hangs in the bull's nose;

Fig. 315.



THE BULL'S RING AS FASTENED IN HIS NOSE.

the joint *a* closed, and the lapped ends *b* also closed with the two countersunk screws, all flush with the surface of the ring. The ring is formed of quarter-inch rod-iron, and its diameter over all is

$2\frac{1}{2}$ inches. The surface should be very smoothly filed, and it cannot be too highly polished with sand paper. It costs 2s.

3822. The ring is put into the young bull's nose in this manner:—It is the smith who puts the ring into the bull's nose. Let him be provided with an iron rod about a foot long tapering to the point, and rather thicker than the rod of the ring. Let a fire be near to heat the point of this rod. The smith should also be provided with a small screw-driver. Let a long stout cart-rop be provided with a noose hitched upon the middle, just large enough to take in the bull's neck like a collar. Put the bull into any outhouse that has a window sufficiently low to allow his head to reach through it, though it is safer for his knees to press his counter against a stout bar of wood. Slip the top of the loop of the rope over his head down to the counter, bring his breast against the window or bar, pass the rope from the lowest part of his neck along the ribs on each side round his buttocks, like a breeching, and bring an end through the window or over the bar on each side of the bull, where let a stout man hold on at each end of the rope, and prevent the bull retreating backwards from the window or bar. A man stands on each side of the bull's buttock, to prevent him shifting to one side or the other. A man also stands on each side of the bull's head, holding on by the horn, or by the ear if he is hornless, with one hand, and keeping out the nose by supporting the jaws with the other. The operator having the iron rod given him by an assistant, heated in the fire just red enough to see the point in daylight, he

takes the bull by the nose with his left hand, and feeling inwardly with his fingers, past the soft part of the nostrils, until he reaches the cartilage or septum of the nose, he distends the orifice of the nostrils, so that the hot iron may pierce clear through the septum without touching the skin of the nostrils or his own fingers, taking care to pass the iron in a direction exactly parallel to the front of the nose, otherwise the hole will be pierced obliquely. Immediately after the tapering rod has been passed as far as to make the hole sufficiently large for the ring, and the wound seared enough, the operator then takes the ring opened, still holding by the bull's nose with his left hand, passes one end of it gently through the hole, and, on bringing the two ends together, lets go the nose with the left hand, and taking hold of the ring with the same, still to command the bull, puts one screw in after another, and secures each firmly with the screw-driver. He then turns the ring round in the hole, to feel that it moves easily, and to see that it hangs evenly, after all which the bull is released. The ring should appear in the nose as represented in the portrait of the Short-horn bull, Plate XI. The ring should not be used until the wound of the nose is completely healed; though it is nothing uncommon to see the ringing of a bull delayed, until the time arrives that he must be led by it for some particular purpose, such as the exhibition for a premium at a show, when, in the attempt to accustom him to be led about by the ring immediately after the operation, every part of the nose being still tender and sensitive, the poor animal is tormented. So alarmed do some bulls become by this operation, that they hang back from the rein-rope in the ring with such force as to tear the ring through the nose; but this is an abuse of the use of the rope, which should be slackened, and the animal relieved from pain, as often and until he learns to yield to the slightest motion of the rope. On first trying to lead a bull by the ring, the drover, who should always be the cattleman that has charge of him, in whom the bull will place more confidence than in any other person, should not endeavour to *pull* the animal along after himself, but allow him to walk on while he remains at his side, or goes behind him, with the rope in his hand.

While so following, to relieve the animal as much as practicable of the weight of the rope upon the nose, the drover should throw the middle of the rope over the bull's back, and retain a hold of its end. Should the bull offer to step backwards, a slight tap on the shank with a stick will prevent him; and should he attempt to *run* forward, a mere *check* by the rope will cause him to slacken his pace. On no account should the drover attempt to struggle with the bull on the first occasion; on the contrary, he should soothe and pacify him, and endeavour to inspire him with confidence in himself and the rope, and to show him that he will receive no hurt if he will but walk quietly along. A bull soon learns what is intended for him when he is properly dealt with; but, if tormented merely that the drover may show his power over him, it may be a long time, if ever, before he will learn to behave quietly when led.

3823. A useful instrument for leading a bull by occasionally, when he has not been ringed, or for leading a cow to the bull at some distance, or for taking away any single beast, and retaining a power over it, is what is named the *bullock-holder*. It consists of iron in two parts jointed, fig. 316, where *a* is the joint

Fig. 316.



THE BULLOCK-HOLDER.

which permits the two parts to open as far as to allow the two small balls at *b* to embrace the nostrils and take a gentle hold of the septum by means of the pinching screw *c*. This form of bullock-holder allows the points *b* to be screwed to every degree of tightness until they meet; and in my opinion, is so far objectionable, as the screwing may be carried, by a rash hand, to hurt the animal severely when the instrument is moved in the least degree to either side. Another form I have used, and approve of, which never allows the two knobs *b* to be screwed closer than just to embrace the septum of the nose, from which the holder swings at ease, whilst it holds the animal with sufficient firmness whenever the

animal attempts to move away. The rein-rope is fastened to the ringed end *e*. The cost of such a holder is 4s.

3824. The leading-rein is best fastened to a ring or holder by means of a spring-hook swivel, such as fig. 317.



SWIVELLED SPRING-HOOK.

The movable part *a* is jointed at *d*, and kept in its place by the spring behind it. When the hook is desired to be attached to the ring, the thumb presses on *a*, which yields, and allows the ring to be taken in the circular void of the hook. The rein rope *b* is spliced on the end of the ring of the hook. This ring, turning upon the swivel *c*, prevents the rope twisting. With such a hook a leading rope can be attached and released from the bull's ring in much less time and with more ease than any sort of tying.

3825. A bull is never in a better position for serving cows than when grazing with them in the field, (2233.) I believe it to be a fact, that a bull which is constantly amongst cows in a field never teases or abuses them, like one taken to them for the occasion out of his own house. But a bull can only be left in the field when he is intended to serve all the cows. It may be necessary, however, in the course adopted for the improvement of stock, that different bulls shall serve particular cows, in which case no single bull can have access to them all, and cannot therefore be grazed in the same field. When a bull goes amongst cows he is usually quite safe to approach, and is quiet within the fence; but one is always troublesome by himself in a paddock or field, or even amongst oxen, and such is his desire to be with the cows, that few fences are able to retain him. He is constantly restless, often bellows, especially where he can snuff the cows at a distance. In such circumstances he should either be confined to his

hammel or byre, and supported on cut forage of some kind, or allowed to be with the cows he is to serve in a separate field from the rest.

3826. When confined, bulls, like watchdogs always kept on the chain, dislike the approach of any one but their keeper; and even a keeper has been known to fall a victim to his resentment of others. Some bulls become so prone to mischief, when constantly confined, that they will attempt to run at every person, when brought out of the house to serve a cow—the presence, or smell of the cow in heat apparently having so maddening an effect upon them as to render them reckless. Air and daylight together seem to have an intoxicating effect upon them. I have observed that Alderney bulls are particularly reckless in such circumstances. Besides the rope or chain in the ring, a safe precaution for the keeper, in such a case, is to have a stout stick about 6 feet long, with a swivelled spring-hook, like fig. 317, on its end to fasten into the ring, which gives him a better command over the ring than the rope merely; and it also enables him to keep the bull off to a certain distance, and to prevent his making a rush without giving warning of his intention by pushing the stick. A mode recommended of taming a savage bull when at liberty, consists of the action of an apparatus, attached to the point of one of the horns, which pulls the ring so tight in the nose by means of a short chain, that when the bull sets his head to use his horns, its action immediately causes him desist from it.*

3827. Bulls often display a natural fondness for calves. A calf of mine, afflicted with scouring, lay for the most part of the day in the cow pasture from weakness. Whenever the proper medicine for its state was brought into the field, the bull came and watched the proceeding with interest, and on the calf being left, went to it as if to examine whether or not it had sustained injury, and then went his way. He was often seen licking the calf with his tongue, and persuading it to rise to its feet.

3828. Bulls that have served cows

should never be allowed to herd together, as they will inevitably fight; and a serious bull-fight is a terrific sight, seldom terminating before the infliction of severe injuries on both combatants.

3829. Bulls can serve a large number of cows in a season, amounting to 60; but where a bull is confined to the service of cows on the owner's farm, he will be restricted to a much smaller number, as few farmers of the mixed husbandry have above 20 breeding cows, with a few heifers, though most permit the service of a certain number of cows of the neighbourhood.

3830. When bulls gain premiums at agricultural shows, a common condition imposed upon them is, to serve a certain number of cows in a prescribed district. The number of the cows is generally restricted to 60, and the fee for service is fixed at from 10s. 6d. to a guinea each, besides a small gratuity to the keeper of the bull. The bull is kept at a convenient station, and not travelled, the cows being brought to him.

3831. On *carse* farms it is not necessary to keep bulls; the number of cows being kept for the purpose of merely giving milk to the farmer's house and the servants, it is more convenient to purchase cows giving milk than to keep them, and put them to the bull.

3832. On farms in the *neighbourhood of towns*, the dairy husbandry is so far practised as to have cows to supply new milk to customers in town; and the practice is to milk the cows as long as they give milk profitably, and feed them, and purchase others new calved or about to calve, rather than to put them to the bull. Bulls are unnecessary in such a case.

3833. On farms distant from towns practising other than the mixed husbandry few cows may be kept, and these more for the purpose of supplying milk than for breeding; nevertheless they are not sold every year, calves being taken from them and fed as veal, for which purpose the cows are kept in calf, and bulls are required.

3834. On *pastoral* farms bulls are always kept to serve the breeding cows, and their number is in proportion to the extent of the breeding stock. The cows bringing up their calves at their feet, the bulls accompany them in the pasture, and attend them as they require their services. So promiscuous is the intercourse of the bulls with the females in the herds of upland pastures, that

many of the queys are in calf as well as the cows; and so much uncertainty attends this portion of pastoral husbandry, that no lot of upland queys can be purchased at the fairs in autumn with the assurance that they are not in calf. The assurance may be given, because the owner does not know to the contrary, and the risk is run by the purchasers, very few of whom escape disappointment.

3835. On pastoral farms in which sheep alone are bred, bulls are useful to keep the cows in calf that are required to supply milk to the people on the farm; and such farms are too far removed from towns to make it convenient for the farmers to purchase cows in milk, just and always as they are wanted.

3836. Dairy farms, whether large or small, require bulls, which are generally fully employed in summer at home.

3837. Among the instances of extraordinary trials, those in which bulls were placed at the bar, convicted and sentenced, are not the least curious:—"In 1314, a bull having killed a man, by tossing him with his horns, was brought before the judges in the province of Valois, and indicted as a criminal, and, after several witnesses had given evidence, it was condemned to be hanged. This sentence was confirmed by an order of the parliament, and carried into effect. And we are told that an unfortunate pig, which chanced to kill a child in Burgundy, was in like manner solemnly tried in court, and suffered the same punishment."* I have heard of a shepherd's dog having been condemned in Scotland along with his master, for assisting him in a very artful manner to steal sheep on many occasions.

ON THE WEANING OF CALVES.

3838. We left the calves in the court & Plâte II., receiving the treatment most proper for them, until the period should arrive for weaning them from milk and other food, and causing them to maintain themselves upon grass, (2288) and (2289.) That period having arrived, we must now proceed to the consideration of the best mode of weaning them. It should not exceed, in the latest case, one month after the cows have been on grass—that is, by the end of June; for a calf later weaned than that period, has been too late brought into the world to be worth belonging to the standing stock of a farm. As cows increase in milk after the grass has safely passed through them, the latest calves should have as large an allowance of new milk, three times a day, as the small quan-

tity reserved for the use of the house will allow. The eldest calves are off the sweet-milk by the time the cows go to grass, and receive skimmed-milk with lythax (2278) amongst it, and cut swedes and hay, until the grass be ready. The most convenient grass-field at first for calves is a contiguous paddock, from which they should be brought into the court for a few nights, and receive turnips and hay until the grass has safely passed through them, and the weather prove sufficiently mild and dry for them to lie out all night on the grass. The youngest calves now leave their cribs R, and pass a few days in the court & Plâte II., until accustomed to the air and sun—the latter readily blistering their ears—before they are put into the paddock during the day, where they then receive their diets of milk, and are brought into the court at night until the temperature permit them to lie out all night on the grass. In weaning the youngest calves, the milk should be gradually taken from them, without giving any other food but grass, until they entirely depend upon it.

3839. The older calves may be 4 months old before they are weaned; but as the season of grass approaches, the younger ones may be weaned at an earlier age, being seldom indulged with milk for more than 13 weeks. But it should never be forgotten, that the first month's good milk to a calf is of much greater importance to its future growth and health, than at any period beyond the 13 weeks, supported on a stinted allowance of inferior milk, and the reason for the generous treatment is given below, where the functions of the calf's stomach is explained.

3840. There are parts of Ireland where calves are brought up on butter-milk and gruel, after the first 8 days they have received sweet milk, and it is alleged that they thrive well on that beverage. This is possible, but they will thrive much better on sweet-milk.

3841. By the time all this has happened, say by the middle of July, the pasture in the paddock will have become too bare, and the whole lot of calves should then be

* Forsyth's *Hortensius*, p. 267.

taken to good pasture, where they will have a full bite; and nothing can be more injurious to their future welfare than to allow them to fall away in condition immediately after weaning, which they will assuredly and rapidly do, if not put on the the best grass; and from a loss of condition thus occasioned, it will be very difficult to recover them during the whole season. The best pasture for them is where the white clover most abounds.

3842. Calves may be grazed amongst cows, or young cattle. In their herding, those which have been brought up and weaned together, will be the chiefest companions for the greater part of the season.

3843. Calves which have been brought up at the pail, and in the earliest period of their existence, are subject to a complaint called *gasteritis*, or inflammation of the stomach. Its symptoms are the distension of the paunch, the inner mucous lining of which is inflamed, and it mostly contains a quantity of dirty, yellow, offensive fluid, and whitish matter often larger than a person's fist, composed of the coagulated ingredients of the milk, the density of which is nearly equal to that of cheese. None of the cheesy matter is found in the intestines, and but rarely in any of the stomachs except the first or paunch. Loathing of the food ensues, and at last total suspension of the appetite. The animal prefers to stand, and when it lies down, it is on its right side, the left being swelled. Grating of the teeth and eructations ensue. The stools are mostly thin, of a whey-like appearance, and small in quantity. The animal shows uneasiness by looking round to the left side, and kicks at the belly with the hind legs. A stupor at last comes on the animal standing with its head in a corner, or pushing with it against the wall.

3844. The remedial measures will be best understood after hearing the rationale of the disease as explained by Mr Barlow, veterinary surgeon in the Veterinary College of Edinburgh.—“In the adult ruminant,” he observes, “the first three stomachs are of great size, and serve to prepare the coarser particles of vegetable food for the action of the fourth or true digestive stomach. The young calf, however, is not physically fitted for living on solid food; but, like the young of other mammalia, is naturally nourished by milk, a fluid which needs not the action of the first three stomachs to render it fit for digestion and absorption. In the calf, at the birth, consequently, and for some time afterwards, these three first or preparatory stomachs are infinitely smaller in proportion to the fourth, than they are in more advanced life, being, in fact, as yet but rudimentary organs. The calf is also naturally adapted for taking in its food by sucking, a process by which the milk enters the alimentary

canal so slowly as to allow it gradually to pass by the three first stomachs through a comparatively narrow channel into the fourth stomach, which is the only one, as it were, necessary to perform the digestion required at this early age. If, however, as is sometimes customary, a large quantity of milk is poured into the calf immediately after birth, or if at once allowed to drink freely from the pail, which it very readily learns to do, then it will swallow as much in two minutes as would probably require 15 minutes to take in by the act of sucking. The consequence is, that the narrow œsophageal passage, leading through the three first stomachs, does not admit the milk as fast as it is swallowed, and that fluid is, from time to time, transmitted into the small rumen, which continues to descend according to the amount collected. The rumen, however, it is seen in so young an animal, is not fitted for very active functions, and the milk retained there, being exposed to the warmth and motion of the organ, undergoes certain chemical changes, which end in the formation of its coagulable principle into the cheesy masses before noticed. These collections act as irritants to the parts containing them; inflammation is the result, and the extension of this, with its consequences, causes death.”

3845. The obvious remedy is prevention. Give the young calf milk frequently, not less than thrice a-day, and in small quantities at a time, perhaps an imperial pint. Let it take time to drink it, and as the quantity should be small, it should be the richer, that is the pure milk. As the stomach increases in size the quantity of food should be increased; and in time other kinds of food should be added to the necessarily limited quantity of milk the calf gets to drink as it attains size and age.*

3846. Calves, after being weaned, are subject, towards the end of summer, to a disease commonly called the *joint-fellon*, which, when oxen take it upon the loins, is named the *chine-fellon*. It is nothing else than acute rheumatism, ending in a resolution to low fever; and so severe is it at times upon calves, that they cannot bear to be moved when lying stretched out all their length upon the ground. Were sheds erected in the fields for cattle to retire into, whenever a dash of rain comes in the evening of a cold day, even in summer, this disease would perhaps never occur. Its treatment is removal to the courts and sheds of the steading amongst straw, bleeding, moderate purging, with fomentation, and embrocations of liquid blister, forcibly and long rubbed in, on the swelled joints.

3847. Another effect of the same febrile affection in calves in autumn is the *quarter ill* or *evil*. “Its characteristic symptoms are general disturbance of the circulation, and feeble, rapid pulse, weakness, prostration of strength; determination of blood to particular, but in different instances and epidemics, very different, parts; producing pain, and manifesting a tendency to inflammation, but of a degenerate kind, so that

* *North British Agriculturist* for 2d July 1849.

the very texture of the tissue becomes disorganised. The progress of the disease is often rapid, and the result very fatal. In some cases the lungs or heart are attacked, in others the liver, bowels, or even some external part of the body." Its immediate cause is plethora, or fullness of blood in the system, which shows its effects in this manner:—"When the supply of food is greater than the exigencies of the system require," as Professor Dick observes, "an animal usually becomes fat, but still may be tolerably healthy. When, however, a sudden change is made from poor to rich feeding, not fatness but plethora may be the consequence; more blood is formed than the system can easily dispose of, and it becomes oppressed. The effect is often witnessed in cattle and sheep, which, after indulging for a time in luxuriant pasture, take what is called a *shot of blood*. All at once they become very ill; some part of the body swells, becomes puffy, as if containing air, and in two or three hours the animal is dead, from the *quarter-evil* already described. Upon dissection, a large quantity of black and decomposed blood is found in the cellular membrane, which during life was distended."* This disease is of frequent occurrence on farms where fine stock are bred, and from the above description of its nature, there is no wonder that the best calves first fall victims to it. As its name implies, the disease attacks the hind-quarter, and its effects are as sudden as described. Since its cause is known, calves should not be put at once on strong rank foggage or aftermath—which is the renewed growth of grass after it had been cut for hay or forage—from a comparatively bare pasture; nor, for the same reason, should they, when in low condition, be put on rank foggage; the transition, both as regards the pasture and the state of the calves, should be gradual.

3848. As a preventive, some farmers introduce a seton into the dewlap of all their calves before putting them on foggage in autumn. The use of the seton is to produce counter-irritation. The seton consists of a piece of tape or soft cord passed under a portion of the skin by a seton-needle; the ends may be tied together, and the cord may be moved every other day from side to side, being previously lubricated with oil of turpentine or blister-plaster, and in this way the amount of irritation may be regulated. As to the cure, I believe every one is unavailing after the disease has been observed to exist; but as a remedial measure applied by anticipation, large blood-letting with purging of repeated doses will reduce the plethoric tendency of the animal system. Perhaps a cribful of hay, with some salt, placed in a foggage field, would not be a bad alternative for calves to resort to at times, in order to modify the effects of the succulence of the rank aftermath. But the best *preventive* is the administration of oilcake. Mr John Wilson, Edington Mains, Berwickshire, gives his calves oilcake towards the middle and latter end of the grazing season, and before they are put on aftermath, and since he has followed this practice he has never

lost a calf from this disease. The quantity given depends on the wetness or dryness of the season, and the strength of the calves. The drier the season, and the stronger the calves, the quantity is the greater. From 1 lb. to 2 lb. a-day to each calf, as it increases in size, will suffice.

ON THE PASTURING OF FARM-HORSES IN SUMMER.

3849. From the time of the sowing of the oat seed until the completion of the turnip seed, the horses may be said to have enjoyed no rest; and, in the long hours of labour in a period of not less than 14 or 15 weeks, the best food that can be devised to support them in strength and condition will not have prevented them falling off in condition. The time, however, has now arrived when comparative leisure awaits them for a while—to enjoy for several weeks to come the food most congenial to their taste—the palatable green food and the much-loved pasture.

3850. The usual treatment of farm-horses in summer is to make them lie out in the pasture-field all night, and give them cut grass between the yokings in the stable. Forage is then supplied them, because the time is too short to fill themselves with grass on pasture; but where the first yoking is over by 9 or 10 o'clock in the forenoon, as on the Borders, the horses are put on pasture until the afternoon yoking at 1 o'clock; which plan saves the trouble of cutting and reserving grass for them. The grass thus allotted to the horses is cut by the ploughmen, who each take the duty for a week by turns, and he quits the field-labour in time to cut the requisite quantity and cart it to the stable; and the man who works the mare that has a foal is a very proper one to do this work. It is no part of his duty to supply the horses' racks in the stable with grass, except those of his own. The load of grass is usually emptied on the ground near the stable door, which is a dirty and slovenly practice. No doubt, it is better for the grass to keep it fresh in the open air than to put it into a house; but it might be emptied into a crib in a convenient shady place near the stable, or, what is best of all, allowed to remain in the cart

* Dick's *Manual of Veterinary Science*, p. 11 and 58.

that brought it, out of which the men can as easily take it as from any other place or receptacle.

3851. The stable is the usual place where horses receive their forage; but a better place, in every respect, for room, air, and freedom, is the hammels M, Plate II., and Plate I., which are now unoccupied and cleared out of the manure, each hammel accommodating a pair of horses. Forage may here not only be given to horses between the yokings, but at night, if desired; and little straw is required for litter, as the part only under the roof is occupied as the night apartment, although more litter will be required in the hammels when the horses are fed on cut grass than in the stable, when on corn and hay.

3852. From 3 to 3½ months, from the beginning of June to the middle of October, is as long time as farm-horses should lie out at night on pasture. Work-horses suffer much from chilly nights, and the cold then lays the foundation of diseases, such as rheumatism, costiveness, stiffness of the limbs. The aftermath may be good pasture after the middle of October for the interval of work at noon, and the second cutting of clover will last long enough for suppers until it is time to betake to the stable altogether.

3853. Young horses are put to pasture during the day as soon as they can obtain a bite, and should be brought, at night, into their hammels until the grass has passed completely through them; after which they should lie out all night in a field which offers them the protection of a shed. The work-horses don't care for a shed on pasture, being too much occupied with eating all night to mind it. But in rainy weather they should be kept in the hammel, on cut grass, rather than be exposed to the rain in the field all the night, as also on a rainy Sunday.

3854. A good watering-pool is essential to every pasture-field occupied by horses of every age, which are as fond as cattle are to stand in the water in the midst of a pool, to avoid the torment of flies, though they drink from a trough quite willingly.

3855. The farmer's saddle-horse should

have grass in summer, as the best course of physic he can have; but it is much more convenient to give him cut grass in a court or hammel than to send him to pasture, in which he will be with considerable difficulty caught when wanted when in company with young horses; and if he is with the work-horses, he will feel lonely when they leave him during the day, and will hang about the gate of the field in their absence.

3856. It is surprising with what constancy a work-horse will eat at pasture. His stomach being very small in proportion to the bulk of his body, the food requires to be well masticated before it is swallowed; and as long as that process is proceeded with while the grass is cropped, no large quantity can pass into the stomach at a time. The horse, like all herbivorous animals, grazes with a progressive motion onwards, and smells the grass before he crops it. His mobile lips seize and gather the stem and leaves of the grass, which the incisors in both jaws bite through with the assistance of a lateral twitch of the head. When the grass is rank he crops the upper part of it first, and when short, bites very close to the ground.

3857. Horses should not graze amongst sheep, as both bite close to the ground; but horses, particularly work ones, often injure the sheep that come in their way, either by a sly kick, or by seizing the wool with their teeth.

3858. During the hard work of the seed-time, farm horses are, in some seasons more than in others—the wet and warm seasons—subject to have galled shoulders and backs, which, when not attended to, are apt to produce troublesome sores. The skin not only becomes abraded by the collar and saddle, but the flesh irritated and inflamed; and if the irritation is kept up, an ichorous discharge takes place, which is difficult to heal without making the horse rest from work. When a saddle gall is observed, the harness should be looked to, and the pressing points which have caused the sore should be relieved. A lotion should then be used to anoint the bruised parts every night, after they have been washed with warm soap and water, and dried with a soft cloth. The lotion is made in this manner: Take hot lime shells of the bulk of 2 quarts, and pour upon them 2 quarts of cold water; and after they have intimately combined, pour off the liquid into a dish. Add to the liquid 5 wine glassfuls of linseed oil, and 2 ounces of sugar of lead, dissolved in a little water.

Stir them together, and then bottle and cork up the lotion for use. After the bruises have been washed in the evenings, anoint them with this liquid with a feather until the wounds heal.

3859. Work-horses, when on grass, are subject to few distempers, the principal being annoyance from a host of insects; and amongst these the common Horse-fly or Cleg, and the Bot-fly, are the most troublesome. The *cleg* or *gleg*, a term derived from the Danish *klaeg*, *Hæmatopota pluvialis*, represented in fig. 318, is so well known,

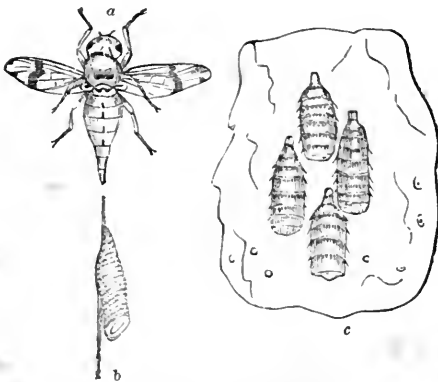
Fig. 318.

THE CLEG OR GLEG—HÆMATO-
TOPOTA PLUVIALIS.

that a particular description of it seems unnecessary. It may be said generally of the tribe of *Tabanidae*, of which this is one, that they appear in June, and come into full force in autumn. They are more plentiful in the southern than in the northern parts of the country. They delight in warm and sultry weather; are most active on the wing during the day, and therefore most troublesome to horses and cattle when they stand most in need of repose. They are particularly excited and eager for blood when the atmosphere is in a warm and humid state, such as it usually is after a thunder shower; and it is this circumstance which has obtained the specific name of *pluvialis* for the cleg. A remarkable fact in reference to this species is, that the males are seldom seen, their numbers seeming to be remarkably few in proportion to those of the other sex; and they appear to subsist entirely on the juices of flowers, and, in conformity to their innoxious habits, the organs of the mouth are much less developed than in the female.

3860. Another pest to the horse is the Great Spotted Horse-bot, *Gasterophilus Equi*, seen at *a*, fig. 319. It is about 7 lines in length; general

Fig. 319.



THE HORSE-BOT—GASTEROPHILUS EQUI.

colour clear yellowish-brown: thorax inclining to grey; abdomen rust-brown with a tinge of yellow; wings whitish; and legs yellowish. The antennæ are inserted in the cavity of the face. The eyes are equally distant in both sexes; mouth either entirely wanting, or consisting merely of an indistinct line or opening. This insect takes no nourishment of any kind; in fact, the alimentary canal has no opening at its anterior extremity. It flies in company, producing a humming sound. "The female having selected the horse to which her treasure is to be intrusted," says Mr Duncan, "she continues to hover about for a short time till the egg be propelled through the oviduct, and placed in the pincers at the extremity of the anal tube. Thus prepared, she makes a sudden descent upon the horse—her body carried nearly in a perpendicular direction, and the ovipositor curved forwards—and deposits the egg upon a hair, to which it instantly adheres by means of a glutinous matter secreted along with it. This process, which is performed with such expedition that the fly can scarcely be said to alight on the horse, is repeated at intervals till the whole of the mature eggs are discharged." These eggs, which are very numerous, 400 or 500 being sometimes placed on a single horse, are somewhat punch-shaped, and chagreened with transverse and longitudinal striae, as seen at *b*. Under the guidance of an instinct which cannot be sufficiently admired, the fly almost invariably attaches her eggs to some part of the fore-quarter of the horse, the inside of the knee and the shoulder being the spots most commonly selected, so as to be within the reach of his mouth; for he is himself to be made the unconscious instrument of conveying them into his stomach, where alone they can be brought to maturity, the temperature of a horse's stomach being as high as 102° Fahrenheit. Even when beyond the reach of the mouth, the eggs are not necessarily lost, for horses are in the habit of licking each other, and a horse free from bots may thus receive them from another. "When the eggs are mature," continues Mr Duncan, "it would seem that the larvæ make their appearance very soon after they are touched by the tongue, the warmth and the moisture both contributing to their immediate development. Indeed, if the larvæ were not disclosed before reaching the stomach, or very shortly after, the eggs would very soon pass into the alimentary canal. The larvæ fix themselves by hooks to the inner tissue of the stomach, where they remain in security, uninjured by the powerful action of the gastric juice, and enjoying the warmth of a tropical climate." A small group of these larvæ adhering to the coat of the stomach are represented at *c*. Their colour is pale reddish-yellow. Their only food seems to be the humors secreted by the internal membrane of the stomach, or it may be the chyme, the latter undergoing a farther elaboration to adapt it to their system. Bots take up their quarters in the stomach in the end of summer or autumn, and pass the whole winter and spring months there, without undergoing any change, save gradually enlarging and advancing to maturity. When that is complete, they cease to retain their hold, pass into the intestinal canal, and are ejected by the anus. On

account of the many ordeals which this insect has to pass in its transformation, perhaps not 1 in 100 of the eggs ever arrive at the perfect state of fly.

3861. The Red-tailed Horse-bot, *Gasterophilus hæmorrhoidalis*, though only half the size of the preceding, is nevertheless a greater torment to the horse. The female parent fly deposits her eggs on the lips of the horse; and this operation is attended with so much pain, that no sooner does it make him aware of the presence of the fly, than he tosses his head and gallops off to a different part of the field; or, if he has the opportunity, betakes himself to the water, where his tormentor generally leaves him, having a peculiar dislike to that element. Indeed all the tribe of gad-flies have; and, to avoid them, it is not uncommon to see numbers of cattle lying on the seashore until the approach of the tide alone compels them to retire. When this fly succeeds in fixing an egg, the horse rubs his mouth against the ground or upon his fore-legs in great agitation, frequently striking out with his fore-foot, which occasionally comes in contact with the jaw, and serves but to increase his irritation. The larvæ are taken into the stomach, and fix themselves there, exactly in the same manner as the greater bot. When they reach the intestines they remain a long time, casting anchor again in the rectum, where they cause great uneasiness to the horse, causing him to kick frequently, and even rendering his movements awkward. These bots should occasionally be looked for in horses that have been out at grass the preceding year, at the extremity of the anus. The only speedy remedy for getting quit of them is in back-raking by the anus.

3862. The more rare species are the *Gasterophilus nasalis*, *salutiferus*, and *Clarkii*. Mr Bracey Clark was of opinion that the presence of bots in no way injured the horse, but on the contrary, by stimulating the stomach, they tend to prevent cholick, gripes, and other indigestions which affect the head of the horse and produce staggers. "The appearance of exanthemous eruptions on the skin," he says, "and the formation of local abscesses, from the same cause of partial irritation, often relieve a general disorder of the system. The mucous membranes of the skin possess this power, when irritated, in the most eminent degree, and to these the larvæ of the *Æstri* are applied. Irritating the membranes of the stomach in other animals would excite nausea and vomiting; but the horse, not possessing this power, his stomach is peculiarly fitted for the stimulus of such animals."*

Fig. 320.

A HORSE-FLY—*CHRYSOPS CÆCUTIENS*.

3863. An annoying insect of less importance, is the *Chrysops cæcutiens*, fig. 320, which is of a bright colour, and though frequent in some parts of Eng-

land, is not so great a pest there as to horses on the Continent.

3864. Another fly, the *Stemoxys calcitrans*, is in size and markings not unlike the common house-fly, *Musca domestica*. This insect attacks various animals, as well as man himself, and becomes very troublesome in certain localities. It attacks the legs, and its punctures are attended with great pain, especially in damp moist weather.†

3865. Another annoyance to horses is the forest-fly, *Hippobosca equina*, fig. 321; its an-

Fig. 321.

THE HORSE FOREST-FLY—*HIPPOBOSCA EQUINA*.

tennæ consist of a single tubercular articulation, with 3 setæ at the extremity. "This insect," says Mr Duncan, "is generally distributed throughout, but it is scarce in all the northern quarters, and does not seem to become abundant till we reach the wooded districts of the central counties of England.

It flies with facility, but seldom appears on the wing except during bright sunshine. June, July, and August are the months it is in force. Its attacks are principally confined to horses. It occasions no other harm than an extreme degree of irritation, and if the flies are numerous, the animal is apt to become unmanageable. It insinuates itself by a sideling crab-like motion beneath the hair, and anchors itself to the skin by means of its large sharply-toothed claws. It also runs about among the roots of the hairs with great ease, creating an insufferable titillation, which is still more increased by the frequent insertion of its proboscis into the pores of the skin. The places to which it prefers attaching itself are the under side of the belly, beneath the tail, and on the under side of the jaws. The insect is so flat, tough, and unyielding, that it is by no means easy to kill it by pressure, and it is, moreover, tenacious of life. It is said that horses long accustomed to its attacks, become, in some measure, indifferent to them; those which have never experienced this plague, which is enough to render some animals almost frantic, may be saved from it, according to M. Küllar, by the following application: Take of mineral earth 8 oz., and of lard 1 lb., and make them into a salve. Some of this salve is to be rubbed on here and there upon the hair, and worked in with a wisp of straw. After 24 hours the salve is to be washed off with warm water, in which brown soap has been dissolved. Care must be taken that the horse does not catch cold.‡ This insect and its allies are neither oviparous nor viviparous. The egg, when fecundated, descends from the ovarium into a kind of matrix, consisting of a large musculo-membranous bag, expressly designed for its reception, and analogous to the uterus of mammiferous animals. The egg is here hatched; and the larva passes its life and is con-

* Clark's *Essay on Bots*, p. 40.† *Quarterly Journal of Agriculture*, vol. x. p. 529-46.‡ Kollar's *Treatise on Insects injurious to Gardeners, Foresters, and Farmers*—Misses J. and M. Loudon's translation.

verted into a pupa in the same receptacle. When the pupa is completely formed, it is then extruded from the body of the mother in the form of a soft, white, oviform body. It soon changes its colour to brown, then to black; and at the same time the skin becomes hard and strong, so much so as almost to resist the edge of a knife. Out of this body the insect makes its exit by a kind of lid."

3866. *Anthomyia meteorica* is often troublesome to horses, by collecting in clouds round their heads in warm weather, and flitting about with a kind of jerking flight, and occasionally alighting on the lips and nostrils of the animal, to his no small annoyance.*

3867. It is amusing to hear the cool manner in which M. Boussingault speaks of permitting the public sale of horse-flesh. "The flesh of the horse," he says, "is not generally used, or at least openly used, as food for man, though there are countries in which it is exposed for sale and commonly eaten. At Paris, indeed, in times of scarcity, horse-flesh has been consumed in quantity. During the Revolution, a knacker exposed publicly for sale, in the Place de Grève, joints from the horses which he had killed, and the sale continued for three years without any ill effect. In 1811, a scarcity obliged the Parisians to have recourse to the same kind of food; and is said, indeed, that the traffic in horse-flesh as an article of human sustenance is still continued to a very considerable extent in the French metropolis. At the present moment, a distinguished writer on medical police, M. Pavent-Duchatelet, has even proposed to legalise the sale of horse-flesh as food for man."†

3868. Nearer home a writer asserts, "It is generally supposed that when horses die, or are killed, the carcasses are converted into food for dogs, cats, or for wild animals in the menageries, but we grieve to have to state that such is not always the case; some portion of this food finds its way into the shops and is consumed, when disguised, as sausages, the horse-flesh tending to give the peculiar redness observable in the sausages. Adjoining to the largest licensed horse-slaughter-house in the city, is the principal sausage manufactory in London, in Sharp's Alley, Smithfield. At the same spot where your olfactory nerves are disgusted with the stench of the knacker's yard, you may distinctly hear the noise of the sausage-machine, performing its work of amalgamation and deception."‡

ON THE SOILING OF STOCK ON FORAGE PLANTS.

3869. Objections have been urged against pasturing grass by any species of stock, inasmuch as *soiling* is a more

profitable and less wasteful mode of using it than pasturing. Although the objections contain much truth, they are thus expressed too generally to be true in all cases. It is evidently impracticable to use mountain grass by soiling. Much cattle and sheep must, therefore, be allowed to pasture; and a great part of the summer would elapse before the old grass of the low country would be fit for the operation of the scythe. What would become of the stock in the mean time?

3870. The other grasses are the cultivated kinds, such as clover and ryegrass, and those on irrigated meadows. It is quite possible to cut grass from water meadows by the time the Swedish turnips are consumed by the beginning of June, but water meadows cannot be formed everywhere. The cultivated grasses are not fit to cut by that time except, perhaps, in the neighbourhood of large towns, and a second cutting from them is not to be depended upon every season. What, again, is to become of the stock in the mean time?

3871. Other plants than clover and ryegrass would require to be cultivated to support the stock until that period. Lucerne and Italian ryegrass might be cultivated for the purpose, but lucerne cannot be generally cultivated in Scotland; and before Italian ryegrass could be cultivated everywhere, a different system of husbandry would have to be adopted—the fourcourse shift—a system which could not be everywhere practised without the support of much more manure than most farms command. Plants that will produce both late and early forage, in a late climate, are not easily found.

3872. In regard to the comparative extent of ground required for soiling and pasturage, it has been alleged to be 3 to 1 in favour of soiling. For example, 33 head of cattle were soiled from 20th May to the 1st of October 1815, on 17½ English acres, which would have required 50 acres to pasture them.§ I would say, that any 33 head of cattle that could be maintained on 17½ acres of cutting grass, would as

* *Quarterly Journal of Agriculture*, vol. xi. p. 51-57.

† Boussingault's *Rural Economy*—Law's translation, p. 629.

‡ *Inquiry into the present state of Smithfield Cattle Market*, p. 10.

§ Sinclair's *Code of Agriculture*, p. 424, and Note, 354, p. 73.

easily be maintained on the same sort of land on 33 acres of pasture — 1 acre of pasture being quite sufficient to maintain an ordinary-sized ox from May to October. So the proportion is reduced to 2 to 1, which I believe is near the truth.

3873. To cut grass, however, for all the cattle on a large farm, to lead it to the steading, and to supply them with sufficient litter in summer, I consider an impracticable thing, were it for no other reason than that the crop of grain on most farms cannot afford sufficient straw to litter stock the whole year; and if the sheep are included in the soiling system, adequate accommodation could not be provided them. The only way to treat them would be to soil them upon the bare land within hurdles, as is common in many parts of England; but such a practice would not suit the variable and wet part of the climate of Scotland. The objection to grazing, in that the manure of the animals is entirely lost, is not a valid one, because land constantly grazed will support stock for an indefinite length of time; and it would not do that, if the ground did not actually receive nourishment in lieu of the grass taken from it. Dissipation of the dung dropped on pasture cannot be great, since no fermentation is ever observed in it. In dry weather the water is soon evaporated out of it, and in rainy weather the water dissolves it among the roots of the grass, converting it into a state of good liquid manure. The greatest waste of dung is from the consumption of it by insects, and yet these leave their bodies in the ground in return when they die. The objection is thus purely theoretical. Cut grass and carry it off every year, and see how long time will elapse ere it can no longer be cut until manure be again applied to the ground. Does not this circumstance of itself show that the dung dropped on pasture is not entirely lost; and that the land derives an advantage from pasturage that it can receive in no other way, such as the fresh state of the urine discharged upon and absorbed by it.

3874. I have often thought that the work-horses might be supported in the steading, night and day, upon cut grass. I have tried the experiment myself twice, in the hammels, and failed in both cases;

at one time for want of cutting grass, the second cutting having entirely failed that year, and the other for want of straw for litter. The straw would have been more economised in the stable than in the hammels; but the stable at night, in summer, even with open windows, ventilators, and no hay-loft, is insufferable; and I am sure that my stables were more comfortably constructed for summer and winter use, than most in the country. The horses required much more straw to keep them dry in the hammel, on cut grass, than on straw and corn in the stable in winter.

3875. Taking every untoward circumstance into consideration, they lead to the conviction that soiling on grass, on a large scale, is impracticable; and until early growth, as well as a late aftermath and plenty of straw, are assured to the farmer every year, general soiling cannot be established, even on a moderate scale. On a small scale soiling might be practised with advantage, and it behoves every small farmer to make his grass go as far as possible.

3876. Where winter tares, crimson clover, lucerne, or sainfoin, and at least two cuttings of red clover, can be certainly secured, as in the south of England they may be, in most seasons, soiling of cattle and horses may be conducted, not without trouble, for the cutting of green forage and carrying it to the steading is attended with much labour, but with advantage to the manure heap, as well to fattening cattle as work-horses; but the system cannot be systematically carried on in Scotland, for want of a regular supply of green forage. Winter tares rarely survive the winter with a sufficiency of plants to make a crop. Lucerne is too delicate, and so is the crimson clover. Winter rye has been proposed, and it withstands the winter very well, and would perhaps be fit to cut in May; but stock are not fond of the herbage of the cereal plants. The Italian ryegrass makes an earlier start, in spring, than any forage plant we have; and, in some situations, it may be cut by the end of May, and the first cutting would continue until the red clover was ready in June. In the former part of the year it might supply green forage, and also later, with due attention for its pro-

duction. In Scotland, the difficulty of soiling commences in August, when the second cutting of red clover fails; and, even when it does not entirely fail, the crop is too light to give an adequate cutting for a length of time. The Italian ryegrass should, therefore, come in also at that season, in case of the failure of the red clover; but it cannot last during the autumn when the cold nights commence in September, and certainly cannot be depended on until the turnips are ready. Tares might come in at this season, but they grow so fast then that portions sown at successive periods run their courses to seed faster than they can be consumed; and towards the latter end of the autumn they are unfitted as a forage plant. Perhaps the maize, or Indian corn, as it is more commonly called, might be sown at such a season, according to its early or late nature, as to afford a good cutting of herbage late in autumn, until the turnips are ready for use. Although the maize may be regarded as a cereal plant, its herbage is more palatable to stock than that of other grain plants, on account of the large proportion of saccharine matter it contains.

3877. Grass is cut with the common

Fig. 322.



THE PATENT SCYTHE WITH BENT SNED.

scythe, which is so well known an implement, that a particular description of it seems unnecessary. The choice of scythes, and the manner of mounting them, are subjects worth attending to. The handle, or sned or snearth, fig. 322, a

b, is made either curved, to suit the sweep of the instrument by the arms round the body, as in the figure, or straight—and the suitability of both for work you shall learn when we come to consider harvest-work. The curved sned is usually made of willow, which, being so shaped in hot water, retains its shape on becoming cold. Another form of sned is that of the cradle, which consists of two pieces of wood, one inserted into the other. Bent sneds cost from 1s. 3d. to 1s. 6d. each, straight ones 1s. each. The straight are made of any sort of wood; I have seen good ones of larch.

3878. Scythes are of various kinds: the common kind keeps its edge but a short time, and in the long run is, I believe, more expensive than the patent kind, which consists of a steel plate with two flat rods of iron, riveted on one of its edges, and which plate will continue to cut keenly until it is worn to the back. The length of the blade of scythes varies from 28 inches to 46 inches, and the price of the common kind varies between these lengths from 2s. 4d. to 3s. 3d. each, and the patent from 3s. 2d. to 4s. 8d. each. There are, besides these, other kinds termed *crown*, *labelled*, and *extra-warranted* scythes.

3879. The blade of a scythe is mounted in this manner:—the sned is furnished with an iron ring at the end a, fig. 322, to which the blade is attached; the projecting stud at the but-end of the blade is embedded flush into the sned, by taking away a portion of the wood; and the ring is then slipped over it, and held tight in its position by an iron wedge, driven between the ring and the sned. The peculiar position which the blade bears to the sned is determined by setting off the length of the blade a c, along the sned from a to d, which is the place for the handle of the right hand, and the same length from d to c fixes the point of the scythe, so that a d c forms an equilateral triangle; the blade standing at an angle of 60° with the sned. Theory would advise the placing of the plane of the blade parallel with the ground, when the scythe is held for cutting; but practice requires the cutting edge to be a little elevated from the ground, and above the back of the blade which sweeps along the surface of the ground; and the reason

for keeping the edge elevated is, that it is apt to run into the ground when swung parallel with it, and the scythe is worked with greater labour, as the stems of the plants are cut by the blade at right angles against them; whereas, on the edge being set upwards, it cuts the stems easily in an oblique direction. The blade is still further secured in its position by the grass-nail *f*, which is hooked by one end into a hole in the blade, and nailed through an eye by the other end to the sned; the great use of this nail being to prevent the cut plants becoming entangled between the

Fig. 323.



A SCYTHE STRICKLE.

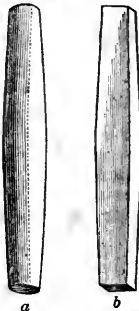
blade and the sned. The left-hand handle *e* is placed to suit the convenience of the workman, the usual distance from the right hand one being the length of his arm from the elbow to the points of the fingers.

3880. Scythes are sharpened with *strickles* and *stones*. The strickles, fig. 323, are made of fine sand embedded in an adhesive medium, spread on the surface of a piece of square or flat wood, 15 inches long, having a handle, and cost 6d. each. They are used to smoothen the edge after the stone, and serve of themselves, for a time, to keep the edge keen; and are always

carried at the upper end of the sned at *b*, fig. 322, by a T-headed nail *a*, and spike *b*, fig. 323.

3881. Scythe-stones, fig. 324, are 14 or 15 inches long, tapering in shape, and of sufficient thickness to fill the grasp of the hand. They are either of a round form, *a*, or square, *b*, and are composed of the same sort of sandstone as grindstones are, and cost 4d. each. They are only occasionally used at the landings, to set a new edge on the blade.

Fig. 324.



SCYTHE STONES.

3882. On using the scythe to cut a forage crop with the greatest ease to the workman, a narrow swathe should be taken at each stroke of the scythe, as also a short sweep. To meet both these conditions, the blade of the scythe should be short.

3883. Green forage should always, if possible, be cut in a dry state, and should not be long cut before being used, nor lie long in the field before it is carried home. When obliged to be cut in a damp state, it may lie a while in the swathe to let the water evaporate, which it will do in warm weather even in a damp day.

3884. Green forage is given to cattle and horses in the natural state, or mixed with straw or hay. When in a very damp state, a mixture of either will tend to prevent fermentation in the green food. When hay and forage are mixed together in equal parts, the mixture makes an excellent fodder for fattening cattle. Such a mixture is much used in Holland for horses, whether employed in the field or on the road.

3885. The clover crop growing closely together prevents the growth of weeds amongst it, an occasional field thistle only, or broad-leaved dock, maintaining its existence. But one of that class of parasitical pests, the dodders, sometimes annoys the crop to a considerable extent. The species which annoys the clover has been named the *Cuscuta Trifolii*, the clover dodder; and its nature and habits are precisely the same as that which attacks the flax plant, as already described in (3117.) Professor Henslow well describes the clover dodder as resembling "fine closely-tangled wet catgut." Of the effects of the *Orobanche major* and *minor*, the greater and less broom-rape, another parasitical pest to the clover in Flanders, Dr Radcliffe says, "The moment it establishes itself at the root, the stem and leaf of the clover, deprived of their circulating juices, fade into a sickly hue, which the farmer recognises, and, with true Flemish industry, roots up, and destroys the latent enemy. If this be done in time, and with great care, the crop is saved; if not, the infected soil refuses to yield clover again

for many years.* And such weeding requires very great care; for, if a part of a stem or one seed is left in the ground, the pest will rise again, and renew its destructive attack.

3886. The crop of clover varies much, according to the nature of the season. In a wet warm one it is very bulky; in a dry one much lighter, but more nutritious. A crop of clover is a great one if it yield 300 stones of hay, of 22 lb. each, equal to 2 tons 18 cwt. 104 lb. the acre; and as Dr R. D. Thomson states, that 100 of hay is equivalent to 387½ of grass,† it follows that such a crop of clover should weigh 8 tons, 16 cwt. 88 lb. the acre. The second cutting is seldom as heavy as the first, though in some seasons it is, and even heavier; but if we assume the two cuttings to yield 16 tons, the quantity will not be under the mark in most seasons. But in some seasons a third cutting is obtained; and when that is realised, it is very nutritious, though not so bulky as either of its predecessors. It is rare that three abundant crops of clover are obtained, and still more rare that they all fail.

3887. Clover will thrive in every kind of soil, and hence the general usefulness of the plant; but its favourite soil is a deep well-limed clay loam.

3888. "In the management of the clover crop," says Dr Radcliffe, "the Flemings are most successful, especially in the division from Waerghem to Courtraï; indeed, upon the cultivation of this plant hinges apparently the whole of the farmers' prosperity; it is here and everywhere, except where vetches are sown, the summer support of all his stock. Here are very few pastures. The clover, cut and carried to well-littered stalls, becomes an abundant source of manure of two descriptions, and thus the cattle are made profitably subservient to the production of their own nourishment. The luxuriance of the clover is surprising, but doubly so when you inquire the quantity of seed sown. In Ireland, for a soiling crop, we cannot be secure of a good one from less than 17½ lb. to the statute acre; but in Flanders, the usual quantity is 6½ lb. to the acre. Can it proceed from the reduced quantity of seed! Whence, then, the superiority of the crop! No—for if even by the reduced quantity upon

our common culture, we shall fail—it is to be accounted for in the fine preparation, and extraordinary cleanliness of the Flemish husbandry. The ground is repeatedly ploughed, and well-manured; no weed is suffered to exist, and the clover plant can tiller uninterruptedly, and possess itself of the entire surface."‡

3889. It is a well-ascertained fact in husbandry, that when the clover plant has been frequently cultivated on the same ground, it not only fails to produce as heavy a crop as it did before, but it ceases to appear. When a failure takes place, the land is said to be *clover-sick*, and explanations on scientific principles have been given of the phenomenon;§ but the failure has evidently no connexion with the kind or quantity of manure employed, since it most sensibly occurs in the neighbourhood of large towns, where the four-course rotation is followed, where the land is heavily manured with extraneous matters in addition to the farmyard dung, and where bone-dust is but scantily applied as a manure. The crop has been recovered in some localities, as in the neighbourhood of Dundee, by extending the members of the rotation of cropping, and making the repetition of the clover less frequent along with the same kind and quantity of manures as were formerly employed.

3890. Mr Keene, in his pamphlet on the Forty Days' Maize, has this observation on the failure of the crimson clover in England:—"The reason," he says, "for its succeeding so rarely in England is, that the *cleansed seed only is sown*; whereas I sow it with the rough pellicle as gathered. This pellicle seems to act as a protection to the young plant till it gets strength. The clean seed sometimes rises as well as the rough, but it invariably drops off in strength, and very often the whole disappears as completely as though none had been put into the ground; whereas the same seed, not cleansed, sown alongside, has resisted the cold temperature of the soil, and turned out vigorous plants."|| The reasons assigned by the writer may not account for the failure, but the fact that rough seeds never failed to grow is valuable, and may lead to the adoption of the practice of sowing the red clover in its rough capsule, and of thereby saving the troublesome process of depriving it of its husk. The hint is worthy of a trial by all cultivators, but especially by those who raise clover seed.

3891. In regard to the value of green food to stock, Boussingault observes, that "breeders have long suspected that green fodder is more nutritious than dry; that grass, clover, &c., lose nutritious matter by being made into hay. That the thing is so in fact appears to have been demonstrated by a skilful agriculturist, M. Perrault

* Radcliffe's *Agriculture of Flanders*, p. 61.

† Thomson's *Researches in the Food of Animals*, p. 71.

‡ Radcliffe's *Agriculture of Flanders*, p. 59.

§ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 85-8.

|| *Facts for Farmers*, p. 9.

de Jotemps, who found that 9 lb. of green lucerne were quite equal in foddering sheep to 3.3 lb. of the same forage made into hay; whilst he at the same time ascertained that 9 lb. of green lucerne would not, on an average, yield more than 2.02 lb. of hay. In allowing each sheep 3.3 lb. of lucerne hay as its ration, consequently, it was as if the animal had had 14.34, or more than 14½ lb. of the green vegetable for its allowance. These practical facts are obviously of great importance: they prove beyond the shadow of doubt that the belief of agriculturists in general, as to the immense advantages of consuming clover and lucerne as green meat, is well founded. Nor is this all; it is not merely the absolutely greater feeding value of the crop green, than of the crop dried and made into hay. There is further, the saving of expense in making the hay; and still further, the escape of all risk from loss through bad weather during the process, by which that which was valuable fodder but a few days before, may become fit only for the dung-hill.*

3892. "A comparative experiment, made at Thorsery, on the relative advantages of grazing with the tether, and stall-feeding, gives," says Von Thäer, the following results:—Four cows, stall fed, during twelve days, gave 1110 lb. of milk; extent of land required, 4344 square yards; quantity consumed, 6144 lb. of clover; which gives for one cow a-day, 23½ lb. of milk; 45½ square fathoms; 90½ square yards; 128 lb. clover. Four cows, pastured by the tether, for twelve days, gave 950½ lb. of milk; extent of land grazed, 3684 square yards; which gives for one cow a-day, 194½ lb. milk; 77½ square yards. Therefore the stall-feeding consumed the produce of 660 square yards more than the pasturage by tether, and, on the other hand, the quantity of milk was greater by 159½ lb. by the stall-feeding. On estimating the milk that would have been yielded by the same extent of land pastured as stall-fed, the result would be that no particular advantage is gained by either side. The dung was more economised by the stall-feeding, but the mowing and carrying of the clover were saved by the pasturage.

3893. "I have never known cattle to be injured by young clover mown before flowering, when it was given to them in moderation," continues Von Thäer. "But if it be given to them in very large quantities at a time, when they are very eager for green meat, or if they are allowed access to the place in which it is kept, it may undoubtedly produce indigestion, and its consequence, the *horen* or *blöten* (1381.) Besides, it is most economical to mow the clover which has put forth its flowers, because in the week during which the flowers come out, the plant increases in volume more than it has done for the five weeks preceding. If a field of clover be mown once a fortnight during six weeks, and each crop yields 30 lb. of fodder, making 90 lb. in the whole,

the same extent of ground will yield 600 lb., if the crop be mown only once during the six weeks: this has been positively demonstrated by a comparative experiment expressly directed to this subject. This is one of the main causes which render the produce of a given extent of surface so much greater when the crop is mown than when fed off, the plants not being allowed in the latter case to attain their full development. The question as to whether a cow yields a greater quantity of milk when pastured or stall-fed, leaving out of consideration the greater or less extent of ground employed in feeding her, can never be decided in a general manner. The same cow which a pasturage of good quality, but not extraordinary richness, will yield 10 quarts of milk a day, may, when stall-fed, yield no more than 6 quarts, or as much as 14 quarts, according as her feed is scanty, or substantial and abundant. If, however, the pasturage be of the richest and most abundant description, so that the cattle are not able to consume the whole of it, I believe that a cow will produce more milk upon it than upon the most abundant supply of green food that can be given to her in the stall. Trustworthy persons assure us, that certain cows fed upon the best and most milk-producing pastures of the low countries, have given from 90 lb. to 100 lb. of milk a-day, at the time of their greatest abundance; and I am not acquainted with any positive instance of stall-fed cows giving more than 60 lb. in the same time."† These observations of M. Boussingault and Von Thäer are valuable, inasmuch as no definite data exist on kindred subjects in the experience of our farmers.

3894. A weevil named *Apion flavipes*, about 1¼ inch in length, with a black shining body, attacks the Dutch or white clover plant, *Trifolium repens*; and as this insect is very common, the cultivators of white clover would require to be on their guard against it.‡

3895. Slugs—*Limax cinereus*—devour the broad leaves of red clover, *Trifolium pratense*, particularly in damp weather.

3896. The composition of the green stems of red and white clover, is as follows:—

	Red clover.	White clover.
Water, . . .	76.0	80.0
Starch, . . .	1.4	1.0
Woody fibre, . . .	13.9	11.5
Sugar, . . .	2.1	1.5
Albumen, . . .	2.0	1.5
Extractive matter and gum, . . .	3.5	3.4
Fatty matter, . . .	0.1	0.2
Phosphate of lime, . . .	1.0	0.8
	100.0	99.9

3897. The composition of the ash of red and white clover, rye-grass, and Italian rye-grass seeds is as follows, and ought to have been given after (2634.):—

* Boussingault's *Rural Economy*—Law's translation, p. 526.

† Thäer's *Principles of Agriculture*, vol. ii. p. 710 and 720—Shaw and Johnson's translation.

‡ *Quarterly Journal of Agriculture*, vol. ix. p. 18.

	Clover.	Red clover.	White clover.	Rye grass.	Italian rye grass.
	BOUSSINGAULT.	SPRENGEL.		THOMSON.	WAY AND OGSTON.
Potash,	35.47	26.70	34.00	8.03	12.45
Soda,	0.67	7.07	6.34	2.17	3.98
Lime,	32.80	37.09	25.72	6.50	9.95
Magnesia,	8.40	4.45	3.34	4.01	2.23
Oxide of iron, alumina, &c.,	0.40	0.20	2.77	0.36	0.78
Phosphoric acid,	8.40	8.80	5.53	12.51	6.34
Sulphuric acid,	3.33	5.98	3.86	...	2.82
Chlorine,	3.47	4.86	2.31	...	2.27
Silica,	7.06	4.85	16.13	64.57	59.18
	100.00	100.00	100.00	98.05	100.00
Percentage of ash in the dry state, 7.70		7.48	9.13*	5.89†	6.97‡

3898. The clover, or trefoil, is cultivated in China. "After the last crop of rice has been gathered in," says Mr Fortune, "the ground is immediately ploughed up and prepared to receive certain hardy green crops, such as clover, the oil-plant, and other varieties of the cabbage tribe. The trefoil, or clover, is sown in ridges to keep it above the level of the water, which often covers the valleys during the winter months. When I first went to Chusan, and saw this plant cultivated so extensively in the fields, I was at a loss to know the use to which it was applied, for the Chinese have few cattle to feed, and those are easily supplied from the road-sides, and uncultivated parts of the hills. On inquiry, I was informed that the crop was cultivated almost exclusively for manure. The large fresh leaves of the trefoil are also picked, and used as a vegetable by the natives." §

3899. The method of a part of the manufacture of scythes, is so curious that I cannot forbear mentioning it. "In the manufacture of scythes, the length of the blade renders it necessary that the workman should move readily, so as to bring every part on the anvil in quick succession. This is effected by placing him in a seat suspended by ropes from the ceiling, so that he is enabled, with little bodily exercise, by pressing his feet against the block which supports the anvil, to vary his distance to any required extent." ¶

ON THE WASHING OF SHEEP.

3900. On the weather becoming mild, and on the likelihood of its continuing so, a pool should be made in which to wash the sheep, preparatory to their fleeces being shorn. The pool should be made in a convenient place in a natural rivulet; and the convenience consists in the banks of the rivulet shelving, so as to admit the sheep being put into the water with little

effort on the one side, and on their walking out of it by themselves on the other. Should the side from which they are put into the water be a little steep, it is less objectionable than having a steep slope for their exit from the water on the other side; for in the sheep struggling to get upon the bank, even with assistance, when their wool is loaded with water and a certain degree of terror affects them, their wool will become inevitably soiled, and decomposed against the earthy bank. When a natural rivulet is awaiting, a pool should be constructed in a large ditch, and in either case the banks should be covered with clean sward.

3901. The next step is to form a damming across the rivulet or ditch, if it have not naturally a sufficient depth of water to conduct the operation of washing. It is better, however, to make a pool than to use a naturally deep pool, as the water will flow from it quicker than the natural current of a deep pool will. The bottom of the river or ditch should be hard and gravelly, and the water pure, or it will not answer the purpose, as a soft and muddy bottom, and dirty water, will soil instead of cleanse the wool. A damming may consist either entirely of a turf-wall built across the stream, though that imposes considerable labour and waste of grass, or what is better, with an old door or two or other boarding, supported by stobs driven into the bottom of the rivulet, to bear the boarding against the weight of water, and the chinks at the bottom and sides of which are stopped with turf in

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 390.

† Thomson's *Researches in the Food of Animals*, p. 80.

‡ *Journal of the Agricultural Society of England*, vol. ix. p. 144.

§ Fortune's *Wanderings in China*, p. 65.

¶ Babbage *On the Economy of Machinery and Manufactures*, p. 27.

the inside. When the water accumulates, it falls over the boarding; and in constructing the dam, the overflowing should be as great as to cause such a current in the pool as to carry away all impurities, such as earthy matter, greasy matter, small locks of wool, and scum, quickly. One side of the pool is occupied by the unwashed, and the opposite by the washed

sheep. They are confined in their respective places by hurdles, fig. 40, or nets, fig. 44. To prevent the sheep taking the water of themselves, which they are apt to do when they see others in before them, the fence should be returned along the sides of the pool as far as the men who wash the sheep take up their stations. Fig. 325 brings out all the particulars,

Fig. 325.



SHEEP WASHING.

where the damming *a a*, by means of doors and stobs, is seen to retain the water until it overflows. The net on each side of the pool is returned far enough down both sides. The water is seen to take the men to the proper depth of the haunches.

3902. Everything being thus ready at the pool, the sheep are prepared for the washing. The tups are washed first, either the day or the week preceding the rest of the flock, and the shepherd himself performs the operation with an assistant, to hand each sheep to him in the water. The lambs not being washed, they are temporarily separated from their mothers, and left in a court of the steading until the washing is finished, to save trouble with them at the pool. When the flock is not very large, and the work can be done in the course of three or four hours, the ewes, hogs, and dimonts, when these latter are retained on the farm, are all taken to the pool in a lot. They should be driven to it gently, not to create a heat on them when about to be put into the water. The ewes are troublesome to drive, being in constant search of their lambs and bleat-

ing incessantly; but, notwithstanding the annoyance, they should not be dogged, but rather get plenty of time upon the route, which should be chosen free of dust or mud.

3903. The men who are to wash prepare themselves by casting their coats, rolling the sleeves of their shirts up to the shoulders, and putting on old trousers and shoes to stand in the water. The men should not be barefooted, as they will not be able to withstand the struggling of the sheep with steadiness and firmness. The shepherd and other two ploughmen are quite sufficient to wash a large number of sheep thoroughly; but if the stream be broad, another may be required to save time in handing the sheep from man to man. The three men are represented in fig. 325, *e* being the shepherd, and the last man to handle the sheep, and *d* and *c* are his assistants. At least two other men are required to catch the sheep for the washers, of whom one is seen at *b*. On this occasion the men receive bread and cheese and ale, and also a dram of spirits as a safeguard against being chilled on

standing in the water. The materials are seen at *h*, where the dog keeps watch; he has no occasion to work, but should be present in case of an outbreak occurring. Some stimulant, as good spirits, is requisite for men who stand for hours with the lower half of their body chilled in the water, and the upper half heated by the work. If they had on long fishermen's boots they would less require the fillip.

3904. The *washing* is performed in this way:—While the three washers are taking up their positions in the water, the two catchers are capturing a sheep. The catching is fatiguing work, and, to make it easier, the fold should be made as small as to contain the sheep easily. A sheep is caught, and is presented as at *b* to the first washer *c*, who takes it into the water, and, allowing the wool to become saturated with it, turns the sheep over on its back, keeping up the head, by taking a hold of the wool of the near cheek with his left hand, and the arm of the off fore-leg with the right. With this hold he dips the sheep up and down, from and to him, rolling it over from one side to the other slowly, and causing the wool to wave backwards and forwards, as if rubbing it against the water. These motions are easily effected, the sheep feeling light in the water. In this operation the water becomes very turbid about the sheep, and he continues it till the water clears itself, when he hands the sheep to the next washer *d*, who stands in the middle and higher up the stream. Whenever *c* gets quit of one sheep, another should be ready by the catchers for him to receive into the water. The second washer *d* holds and manages each sheep he receives from the first washer in the same manner, and then hands it to the shepherd *e*, who stands towards the margin and still a little higher up the stream, and is immediately ready to take another sheep from the first man. It is the duty of the shepherd to ascertain if the *skin* of the sheep is cleansed, and every impurity removed from the wool. The position of the sheep on its back is favourable for the rapid descent of earthy matter from the longer part of the wool. Wherever he feels a roughness upon the skin, he washes it off with his hand, and elots upon the wool he rubs out. The belly, groins, breast, and round the head, he scrubs with

the hand. Being satisfied that the sheep is clean, he dips it over the head while turning it to its natural position, when it swims ashore, and gains the bank at *g*. On coming out of the water it walks feebly, its legs staggering under the weight of the dripping fleece; in a little, it frees itself from the water by making the fleece twirl like a mop. In the echelon form, in which the men stand in the water, the sheep have the opportunity, when in its dirtiest state in the hands of the first man *c*, to get quit of its impurities farthest down the stream, where they flow away at once, and do not come near the stations of the other men. The sheep being in a comparatively clean state when it reaches the second man *d*, the water in which it is further washed, cannot much affect that which runs past the first man *c*; and still less will the water in which the sheep are last washed by the shepherd *e*, affect that near either of the other two men.

3905. In this way sheep are washed in the Lowlands; and from two to three scores may be washed in an hour, according to the size of the sheep, the activity of the washers, and the supply of water. After washing, sheep should be driven along a clean route, and be put into a clean grass-field having no bare earthy banks, against which they might rub themselves. They should be kept perfectly clean until their fleeces are taken off. How long the fleece remains on after the washing, depends on the state of the weather, as the wool must not only be thoroughly *dry*, but the *yolk*, which the natural oil of the wool is called, must return into it again; and further, the new wool should be risen from the skin before the old is attempted to be taken off. Disregard to this particular will make good clipping difficult to be accomplished, and it will certainly deteriorate the appearance of the fleece. Perhaps 8 or 10 days may suffice to produce these effects. You need be under no apprehension of the fleece falling off when the new growth commences, for wool will remain for years upon the sheep's back if not clipped off, and the sheep be free of all manner of disease. How many years the fleece might continue to grow I do not know, but I have seen a fleece upon the sheep's back three years old. Lord Western exhibited Anglo-merinos, at the show of the English

Agricultural Society at Oxford in 1839, the fleeces of which were of that age, and, when clipped, weighed I believe 20 lb. each. The lambs are restored to the ewes immediately after the washing.

3906. The afternoon is generally chosen by shepherds as the period of the day for washing sheep, but I conceive that the morning is a better time, inasmuch as the fleece will have become much drier during the day than in the night when the sheep are washed in the evening, and they must feel uncomfortable in the night with a wet fleece.

3907. Sheep are differently affected in the time of washing. Some disregard the plunges, and seem to enjoy them, giving themselves up entirely to the will of the washers; whilst others are in a state of great terror, struggling against every new motion, and groaning in anticipation of greater danger. Some are very expert in turning their backs upwards, should the washer be off his guard and dip them too perpendicularly down, and when they thus turn themselves quickly, they are apt to strike and scratch the bare arms of the washer with the hoofs of the fore-feet. I was once amused by seeing a new hand, though a stout fellow, thrown on his back and soused under water by an old supple ewe turning quickly, and pushing herself against his breast. He held on by her at first, but, on finding he could not regain his feet on account of her impetuosity, he was at length obliged to let go his hold. To make the matter worse to him, he lost both his shoes in the struggle.

3908. Neither *carse*, *dairy*, nor farms in the neighbourhood of towns, support sheep, and therefore have nothing to do with washing them. The washing of sheep on *pastoral* farms is conducted on a somewhat different manner from what has been described. A natural deep pool in a river is selected for the purpose, or, failing this, a damming is made in the gully of a rivulet, or a pool is dug in the plain ground near a supply of water. Where no river exists the edge of a lake is selected. A small space is enclosed with hurdles, fig. 40, near the edge of the pool; a narrow passage fit to contain at most 2 sheep and 2 men in breadth, is made from the hurdles to a jetty, which projects into the pool, and is 5 or 6 feet above the water—and from this the sheep are made to leap into the water one by one. On

leaping from that height, the sheep go over the head, and on swimming across the pool reach the dry land at the opposite side, where another enclosure of hurdles is ready to receive them. They are thus treated several times till they are clean. Where the edge of a lake is employed for washing sheep, stakes are driven in the water and rails nailed to them, to form a space of water in which the sheep are swum, after jumping from the jetty, and land upon the same shore. There are store-masters who prefer hand-washing to leaping and swimming them across the pool. Merely with hand-washing, and without inverting their backs, I cannot see how sheep can be thoroughly washed, especially those which have been smeared.

3909. I have seen it somewhere stated, that the more greasy the water becomes, in which sheep are washed, the cleaner will the sheep be, and, therefore, it should not be changed. I suppose that this opinion prevails generally in pastoral districts, as I have seen no means used there to let the water flow off, except where the side of a lake forms the washing pool. Theoretically, the opinion may be correct, as M. Raspail observes, that "when the wool is washed, this soap, (the yolk) is dissolved, and takes the salts along with it. Hence it follows, that the water that has been used in this process becomes, at each repetition, better adapted for the purpose." Practically, however, the notion of greasy and dirtied water washing wool better than clean will gain no converts from those who have used clean water; besides, every fleece has, or ought to have, as much natural soap in it as will wash it clean in clean water. No doubt *soft* water will wash wool better than *hard*, but all river water, when exposed to the air for some time, becomes soft, unless it contain an inordinate proportion of lime or tannin; but let the state of the water be what it may in particular localities, there is no doubt that wool, like everything else, is best washed in clean water. A greater probability attaches to what M. Raspail states, that "it has been calculated that the grease obtained from the washing of wool in France might be sufficient to manure about 370,000 acres of ground."* In small lots of sheep, I have seen the wool clipped before it was washed. The clipping on a dirty skin makes rough work, but independently of this, wool washed off the sheep's back is deprived of its yolk, and, when dry, feels harsh, and is in an unfit state for certain processes of manufacture.

3910. A curious mode of washing sheep is practised in Würtemberg. Advantage is taken to make a fall of water at a sluice in a river, by means of a number of spouts to convey the water in small broad rills, and let them fall from a height of 5 or 6 feet into the shallow water in the bed of the river. Or a pool is dug out of the plain ground, and water is brought into it from a river or canal, by means of a channel which supplies the number of spouts required for use

* Raspail's *Organic Chemistry*, p. 457.

in the washing of the sheep. Men hold the sheep in different postures, in the shallow water, under the spouts, from which the water falls upon different parts of their body. The water first falls upon the head and shoulders, the sheep being held up upon its rump; it then falls upon the belly, the sheep being placed on its back; it falls upon one side and then upon the other, the sheep being placed upon either side; and lastly, it falls upon the back, the sheep standing in the water. The washers all the time shed the wool this way and that with the bare arm, to let the water reach every part of the body, and not with the hand, in case its manipulation should break the wool. The sheep are first rubbed with soap in a trough in which they are made to stand, and the cost of the entire process is about 1d. a-head.* I would apprehend that the constant beating inflicted by the fall of the water is anything but serviceable to the sheep.

3911. An interesting topic of investigation is the ascertaining the quality of that substance which is most commonly found intimately mingled with the pile of our fleeces, which, on account of its yellowness and consistency, its egg-like appearance, is aptly denominated *yolk*. The investigation of its properties, and of the good effects which it produces upon the fleece while growing, is more properly the business of the grazier than of the wool-stapler, and he has the most abundant means of acquiring information. Hitherto it must be acknowledged that they have been too much neglected; yet the few facts with which we are furnished indicate that, without the assistance of yolk, "or the application of some other substance which shall act as a substitute for it, wool possessing the best qualities cannot be produced. The celebrated breeds of Berry, of Castile, and of Persia, we are informed, furnish the most copious supply of yolk, and at the same time yield those valuable fleeces which are eagerly sought after by the manufacturers of the countries where they are shorn, in order that they may be able to supply even distant markets with the most valuable commodities."

3912. The composition of the yolk has not been particularly analysed, but Vauquelin examined the matter, and found it to consist of a soap of potash, carbonate of potash, a little acetate of potash, lime, a very little of muriate of potash, and an animal matter, which imparts to wool its peculiar odour.† The yolk being a true soap, soluble in water, it is easy to account for the comparative ease with which the sheep that have the natural proportion of it are washed in a running stream. There is, however, a small quantity of fatty matter in the fleece, which is not in combination with the alkali, and which, remaining attached to the wool, keeps it a little glutinous notwithstanding the most careful washing."

3913. "The manner in which the yolk acts

upon the wool," observes Mr Luccock, "is not accurately known. Some have considered it as the superabundance of that substance which forms the filament, and which by some unknown process, while the pile is growing, is consolidated into a transparent mass; while others conclude, perhaps more reasonably, that it is a peculiar secretion, which exudes through the skin, and by intermingling with the pile, renders it soft, pliable, and healthy; affecting it much in the same way as oil does a thong of leather, when kept immersed in it and perfectly saturated. A very curious and interesting question has been asked respecting the mode in which the wool imbibes the yolk, whether by means of the root alone, or also by the pores, which it is supposed may be scattered through the whole length of the hair.‡

3914. The medium quantity of yolk in a Hereford, Shropshire, or Sussex sheep," says Mr Youatt, "is about half the fleece; and this is the customary allowance to the wool-buyer, if the fleece has been sold without washing. More yolk is found on the breast and neck of a sheep than on any other part of the body, and it is there that the finest and softest wool is found. Softness of the pile is, therefore, evidently connected with the presence and quantity of yolk. There is no doubt that this substance is designed, not only to nourish the hair, but to give it richness and pliability. In what way is the growth of the yolk promoted? By paying more attention than our agriculturists are accustomed to give to the quantity and quality of this substance possessed by the animals which they select for the purpose of breeding, the quantity and quality of the yolk, on which many farmers now scarcely bestow a thought, and the nature of which they neither understand nor care about, will, at some future time, be regarded as the very essential and cardinal points of the sheep."§

ON THE SHEARING OF SHEEP.

3915. After the wool is dry, the yolk returned into it, and the fleece has indicated a fresh growth next the skin, the sheep should be shorn of their fleeces; and they are shorn in regular order, the tups being first shorn, to give the longer time for the wool to grow ere the time arrives for selling them, or letting them on hire in autumn; then the hoggs and dinmonts, if there be any of the latter, and, lastly, the ewes.

3916. A place under cover should be selected for clipping the fleeces. The straw-barn, L, Plate II., of the stading, is

* Zeller's *Landwirthschaftliche Maschinen, Apparate, und Gerathe, zweite Lieferung*, p. 15-21.

† Thomson's *Animal Chemistry*, p. 305.

‡ Luccock *On Wool*, p. 80 and 84.

§ Youatt *On the Sheep*, p. 61 and 75.

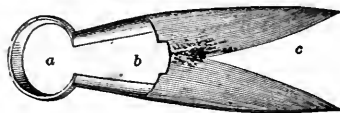
a suitable place for the purpose. The end next the chaff-house *r*, between the two doors, is a good site for the clipping floor, and the rest of the barn contains the sheep cool under cover. The clipping floor is prepared in this way;—Let clean wheat straw be strewed equally over the floor two or three inches thick, and then spread the large canvass barn-sheet over it, (1740,) the edges of which should be nailed down tight to the floor. The straw makes a soft cushion for the knees of the clippers, as well as for the sheep. A broom is required to sweep the barn-sheet clean, (1794.) Any other equally convenient place will answer the purpose of clipping sheep as well as the straw-barn. The barn-floor and walls, as high as the sheep can reach, should be swept of dust, and some straw strewn upon the floor for them to lie clean upon.

3917. In case of dew or rain in the morning, it is customary to bring into the barn as many dry sheep on the previous evening as the number of clippers to be employed will shear on the ensuing day. It is a custom for neighbouring shepherds to assist each other; and though the plan cannot expedite the entire sheep-shearing of the country, yet the emulation amongst a number of men clipping together, expedites the shearing of the individual flock. Other hands besides shepherds are pressed into the service at this time. A steward seldom clips sheep, but the art is mostly possessed by the hedger, and if the cattleman had been a herd, he lends a hand. Clipping being dirty and heating work, the coat is stripped, the hat and vest thrown aside, and the oldest clothes worn. Garters, or tight knee-breeches, are irksome pieces of dress in clipping. It is rare to see knee breeches now-a-days, the long trousers having superseded their use entirely, even with elderly men.

3918. The instrument by which the wool is clipped off sheep, is made of steel, and is named *wool-shears*, which have the form as seen in fig. 326. They require no particular description farther than to explain that the bend or *bowl*, *a*, which connects the two blades, acts as a spring to keep the blades separate, and it is the pressure of the hand on each side of the handle *b*, which overcomes the spring and brings the blades *c* together. Some wool-

shears have additional springs between the handles *b* to separate the blades more for-

Fig. 326.



THE WOOL-SHEARS.

cibly, but are not so agreeable to the hand as the simple round spring *a*. The spring *a* is sometimes made too strong, and tires the hand, to relieve which a piece of cord is wound loosely round the handles. Strong-springed shears are most easily worked if held near the blades; but the sharp backs of these soon hurt the hand. When not in use, and when carried, the blades are held together at their points by a ring of leather. A ragstone is used to sharpen wool-shears. The cost of shears is from 2s. 6d. to 3s. 6d. each, and of ragstones 4d. per lb. A shepherd requires two or three pairs of small shears for jobs, and he only uses the large shears for shearing.

3919. The object of washing the sheep perfectly clean, is apparent at shearing; for if not clean, the shears grate upon the dirt and make bad work; and for this the shepherd alone is to blame who had the sheep last through hands in the water, and the charge of them afterwards on the pasture.

3920. The shears are used in a particular manner, to be safe alike to the fleece and the skin of the animal. The essential particular ever to be attended to in clipping, is to keep the *points always clear of the skin*; for if they rest upon it, they will inevitably either run into it, or make a large gash in it before the clipper is aware of the mischief he is doing. This is an error commonly committed by new clippers, by holding the hand too high above the wool, and is a great offence in any experienced clipper. The sure way of avoiding this serious injury to sheep, is to rest only the *broad* part of the blades of the shears upon the skin; in which position, with the skin drawn a little, not too tight, by the left hand, the shears slide upon it with a hold of the wool with their points, which are never brought nearer than an

inch apart, while the clips are made short and frequent. The form of the sheep's body being round, the shears should not make so long a clip as to bring the points of the blades together at every stroke, for if they do, they will cut the wool with their points at a considerable elevation above the skin, at a point in advance of the place where the broad part is cutting close to the skin; the wool, in fact, would be cut in two places at once. *Very* short clips, no doubt, make slow work, but rather have slow work safely done, than hasty slashing with injury to the wool.

Experience will teach you how to make longer clips effective, when you know how to manage the shears dexterously, but at all times short clips are the safest mode of using the shears.

3921. *Clipping* is done in this way: Whenever a sheep is caught in the barn, the straw or bits of plants on the wool, or dirt on the hoofs, should be picked off before it is taken to the barn-sheet. Clipping consists of three stages, the *first* of which is represented in fig. 327. After setting

Fig. 327.



THE FIRST STAGE OF CLIPPING A SHEEP.

the sheep on its rump, and on the supposition that the clipper is a right-handed man, he rests on his right knee, and leans the back of the sheep against his left leg *a*, bent. Taking the shears in his right hand, and holding up the sheep's mouth with his left, he first clips the short wool on the front of the neck, and then passes down the throat and breast between the fore-legs to the belly. Then placing the fore-legs *b* under his left arm *c*, he shears the belly across from side to side down to the groins. In passing down the belly and groin, where the skin is naturally loose, while the shears *d* are at work, the palm of the left hand *e* pulls the skin tight. The scrotum *f* is then

bared, then the inside of the thighs *g g*, and, lastly, the sides of the tail *h*. These are all the parts that are reached in this position. For the clipping of these parts small shears suffice; and as the wool there is short, and of a detached character, it is best clipped by the *points* of the shears, as carefully held close like *d*.

3922. Fig. 328 represents the *second* stage of clipping. Its position for the sheep is gained by first relieving its fore-legs *b* from their position in fig. 327, and, gently turning the sheep upon its far side, while he himself, resting on both knees, supports its far shoulder upon his lap.

You may always rely upon this fact—the more a sheep feels at ease, the more readily it will lie quiet to be clipped. Supporting its head with his left hand, the clipper first removes the wool from behind the head, then around the entire back of the neck to the shoulder-top. He then slips its head and neck *a* under his left

Fig. 328.



THE SECOND STAGE OF CLIPPING A SHEEP.

arm, *g*, and thus having the left hand at liberty, he keeps the skin tight with it, while he clips the wool with the right, from where the clipping in the first position, fig. 327, was left off to the back bone, all the way down the near side. In the figure, the fleece appears to be removed about half-way down the carcass; the left hand *b* lying flat, keeping the skin tight; while the right hand *e* holds the shears at the right part, and in the proper position. The clipper thus proceeds to the thigh and the rump and the tail *d*, which he entirely bared at this time.

3923. Clearing the sheet of the loose parts of the fleece, the clipper, holding by the head, lays over the sheep on its clipped or near side, while still continuing on his

knees; and he then rests his right knee, fig. 329, over its neck on the ground, and his right foot *b* on its toes, the ankle keeping the sheep's head down to the ground. This is the *third* position in clipping. The wool having been bared to the shoulder in the second position, the clipper has now nothing to do but to commence where it was then left off, and to clear the fleece from the far side from the back-bone, where it was left off in fig. 328, in the second position, towards the belly, where the clipping was left off in the first position, fig. 327.—the left hand *e* being still at liberty to keep the skin tight, while the right hand *f* uses the shears across the whole side to the tail. The fleece *g* is now quite freed from the sheep. In assisting the sheep to rise, care should be taken that

its feet are free from entanglement with the fleece, otherwise, in its eagerness to escape from the unusual treatment it has just received, it will tear the fleece to pieces.*

Fig. 329.



THE THIRD AND LAST STAGE OF CLIPPING A SHEEP.

3924. On comparing the attitudes of the clipper and of the sheep, in the different stages of clipping just described, with those of a mode very common in the country, it is necessary to look again at the *first* stage of the process, fig. 327, the common practice of conducting which is to place the sheep upright on its tail, and the clipper to stand on his feet, supporting its back against his legs—which is both an insecure and painful position for the sheep, and an irksome one for the man, who has to bow much down to clip the lower part of the animal. In the *second* stage, fig. 328, the man still remains on his feet, and the sheep upon its rump, while he secures its head between his legs, in order to tighten the skin of the near side, which is

bent outward by his knees. The skin is certainly tightened, but at the expense of the personal ease of the animal; for the hand can tighten the skin as well, as shown in all the figures, at *b* and *e*; whilst the bowing down so low, and as long, until he clips the entire side, cannot fail to pain the back of the clipper. The *third* position is nearly the same in both plans, with the difference in the common one, which keeps the left leg bent, resting on its foot—a much more irksome position than kneeling on both knees.

3925. All the fleeces are not in the same state for being clipped. Thin watery wool is apt to be clipped in too broad courses—the shears passing through it

* The artist has erroneously represented the sheep lying upon its *far* side, and the clipping to proceed from the belly to the back-bone, which is the proper posture for the second position, as also the keeping the head of the sheep down with the left leg *a*, whereas the sheep should have lain upon its *near* side, the wool been shorn from the back-bone to the belly, and the head *d* kept down with the right leg, as described above.

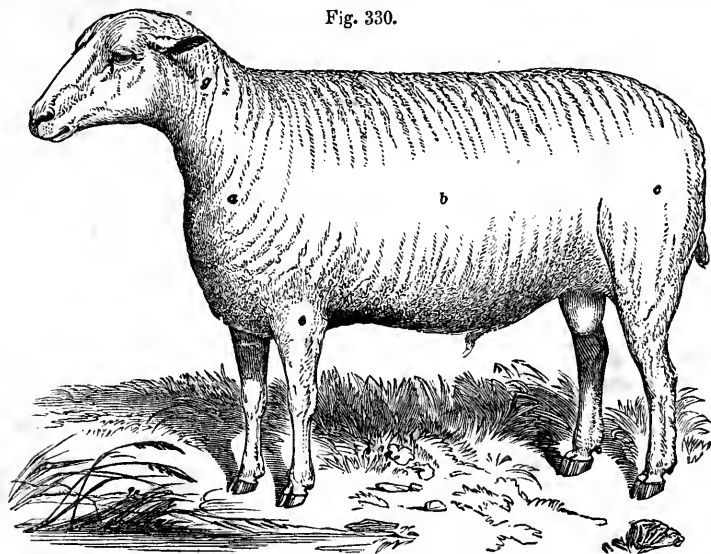
quickly induces the clipper to take more into the clip, in order to withstand the force of his hand. Thick wool requires the shears to be employed more at the points, as these cannot penetrate it so far in advance of the blades as wool in the ordinary state. Certain fleeces become so thick as to be *coated*—that is, felted on the sheep's back; and these can only be taken off with the points of the shears in minute clips, and take longer time in being removed than their value is worth. Such fleeces can scarcely be clipped at all, until a fresh growth of the wool has taken place after the washing.

3926. To shear 20 sheep a-day is considered a good day's work for any clipper, though there are shepherds who can do more. A fat sheep is more easily and better clipped than a lean one.

3927. Immediately that one lot of sheep in the barn is clipped another is brought into it from the field, to be ready to commence the next morning's work. However little it may injure hogs to be kept in the barn all night, it is not good treatment to ewes and lambs; and in order to dispense with it, the shepherd should bring in a few ewes during the day when their wool is dry, to clip while the hogs are clipping; in which way the first shorn ewes would be but a short time confined, whilst fewer ewes would be long confined when the last of the flock to be clipped consisted entirely of them.

3928. A new clipped sheep should have the appearance of fig. 330, where the shear-marks are seen to run in parallel bands round the body, from the neck and counter *a*, along the ribs *b*, to the rump,

Fig. 330.



A NEW CLIPPED SHEEP.

and down the hind-leg *c*. When pains are taken to round the shearmarks on the back of the neck down by *g*; to fill up the space in the change of the rings between those of the counter and of the body above *e*; to bring the marks down from *c* to *f* to the shape of the leg, as far as the wool reaches; to make them run straight down the tail, and to have them coinciding across the back from each side—a sheep in good condition so clipped forms a beautiful object. A sheep clipped to perfection should have no

marks at all, which are formed of small ridglets of wool left between each course taken by the shears; but such extreme nicety in clipping is scarcely attainable, and certainly not worth being attained by the sacrifice of the time occupied in doing it. It should be borne in mind, however, that the closer the wool is clipped to the skin it is the better clipped, and is in a better state for growing the next year's fleece; and what is more, a larger and heavier fleece is obtained from each sheep.

3929. Clipping makes so great a change on the appearance of sheep, that many lambs have difficulty at first in recognising their mothers, whilst a few forget them altogether, and wean themselves, however desirous their mothers may be to suckle them; and as the ewe is content with one lamb, many a twin which does not follow her is weaned on this occasion. It should be the shepherd's particular care to mother the lambs frequently after clipping; but the difficulty of bringing an old lamb and ewe together, without much disturbance to the rest of the flock is great; and besides, the shepherd cannot constantly attend on the clipped portion of his flock while engaged with clipping, and this is one of the reasons why ewes should be last clipped.

3930. Sheep-shearing is a joyous season—a sort of harvest—in which a liberal allowance of beef and broth and ale is dispensed to the clippers engaged in the laborious but important work.

3931. No sheep-shearing takes place in *carse* farms, or *dairy* farms, or on farms in the vicinity of towns. The clipping of sheep in most pastoral districts is conducted in a most slovenly manner. The old-fashioned practice of tying the legs of the sheep together, on the grass sward in the open air, is still practised in most parts of the Highlands; and after the creature is thus placed in a helpless state between the legs of the clipper, who sits on the grass with the head of the sheep towards him, the shears are made to ply, from the neck to the tail, in irregular long slashes, so that the fleece may be said to be snatched off in the shortest time. The legs are then loosened and the sheep set at liberty. Women are frequently employed at this work, to which there is no objection, provided they do it properly; but the result is, that a considerable proportion of the wool is left on the sheep, and their appearance, as a piece of work, is most disgraceful. The entire proceeding is the less justifiable, that the proper way can be done as expeditiously in the hands of dexterous people as any slovenly method. If hill-herds cannot clip in any other way, let them go and learn it in places where it is better done.

3932. An improvement has been effected on the mode of clipping sheep in one pastoral district by Mr Colin Munro, Dingwall. It consists of erecting an awning of canvass, fastened to stobs driven into the ground at stated distances, and of appropriate heights, along the side of a wall. This tent, as it may be called, is sufficient to hold as many sheep as is desired, by making it large enough; it protects them from rain, allows the clipping to proceed uninterruptedly, and screens

the workers from the heat of the sun. If the part of the ground occupied by the clippers were covered with barn sheets, the wool would be kept clean. A tent of this sort can be erected at little cost, and would last many seasons. Still no pastoral farm should be without a steading, and a part of it should be made suited for so necessary a process in a sheep-farm, such as the straw-barn *c* fig. 55.

3933. The deprivation of wool before the warm weather has appeared, induces diseases in sheep. It is seldom that a flock-master errs in this respect, though cold nights do sometimes occur after the shearing of the tups in cases where their owners are desirous of clipping early, that the wool may have the longer time to grow before the season arrives when tups are sold or let on hire. But the practice of shearing fat sheep early, before they are sent to market, is thus very properly deprecated by Mr Youatt. "There is scarcely a Smithfield cattle show in which, in the dead of winter, two or three sheep just shorn—certainly in a very neat and tasteful way, and every excellent point of the animal displayed—are not exhibited. Some excuse may be made for this, for the sheep are brought to the metropolis in closed carts, and are shown in a place where the winds of heaven cannot visit them too roughly; but what shall be said of a drove of naked sheep going to market in the early part of March—the east wind cutting like ice, and their eyes and noses nearly closed with mucus! This is done for the sake of the little additional profit to be derived from the wool. Is that profit really derived? Has not the unfeeling owner miscalculated the matter? Let him, or let any thinking or humane man, compare two pairs of sheep close by each other. In the one the animals retain their natural covering, and they are full of health and vigour; the inhabitants of the other hang their heads with cold and disease, an unpleasant stream is discharged from their nostrils, and the eye of the sheep that never deceives when the question of health is to be decided, tells tales, far too intelligibly, of pulmonary diseases, and of constitution undermined, and of everything to disgust rather than attract. Has not the unfeeling owner miscalculated the matter? He will say, perhaps, that the sheep will not well travel in their fleeces. In the heat of summer they will not; but when the winds blow chilly, no system can so surely promote the health of the animal as that which secures to him the feeling of comfort."

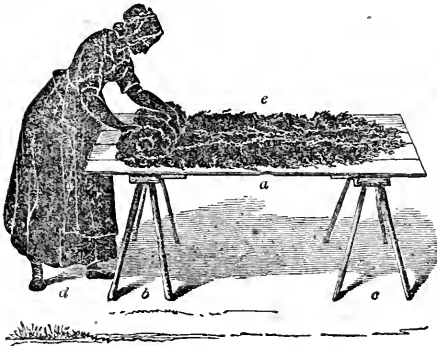
ON THE ROLLING OF FLEECES, AND ON THE QUALITY OF WOOL.

3934. Wherever the sheep are shorn, whether in the straw barn or in a shed, a board is erected, for rolling the fleeces upon as they are shorn. A smooth plain deal painted door makes a useful and good board

for winding fleeces upon, and it should be supported on tressels about 2 feet above the ground, and 2 or 3 feet from a side-wall, near the clippers. A chaff-sheet (1749) should be spread on the floor close to the same wall, to pile the rolled fleeces upon until they are taken to the wool-room, at the end of the day's work.

3935. The person appointed to roll the fleeces is one of the field-workers who has been accustomed to the work, and she, whenever a fleece is separated from the sheep, lifts it carefully and unbroken from the shearing cloth, and spreads it upon the board upon its clipped side, with the neck end farthest from her. She examines the fleece carefully, that it be quite free of extraneous substances, such as straws, bits of thorn, of whins, or burs, and removes them; and she also pulls, not clips off, all locks having lumps of dung adhering to them, which may have escaped the notice of the sheep-washers. Fig. 331 shows the mode of rolling a fleece

Fig. 331.



THE ROLLING OF A FLEECE OF WOOL.

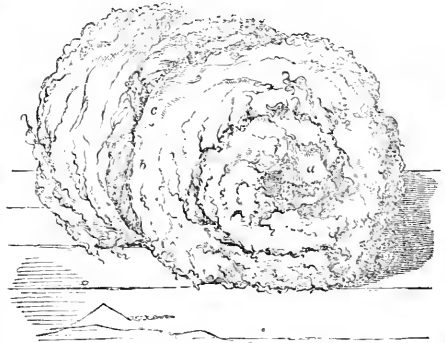
where *a* is the board supported on the tressels *b* and *c*, and *d* is the field-worker in the act of winding the fleece *e*, placed as above described.

3936. The farmer should be very particular in giving instructions to have every fleece as clean as possible, as the purchaser cannot unloose every fleece he buys; and should he find as much filth in the fleeces, after purchasing them, as to warrant the belief that it had been purposely left there, he may either relinquish his bargain, or make a large deduction from the price—in the former case implying fraud on the

part of the farmer, and in the latter diminishing his profits. Besides the disgrace of the attempt to commit such a fraud, the farmer is amenable to a criminal charge of fraud and imposition by the common law of Scotland.

3937. The winder being satisfied of the purity of the fleece, folds in both its sides, putting the loose locks into the middle, and making the breadth of the folded fleece from 24 to 30 inches, according to its size. She then rolls the fleece from the tail towards the neck, tightly and neatly; and when arrived at the neck, puts a knee upon the fleece, while she draws out the wool of it, twisting it in the form of a rope with both hands, as far until it will go round the fleece; and then holding the fleece tight at the lower end of the rope thus made, with one hand, removes the knee, and still holding the point of the rope in the other hand, she winds the rope tight round the fleece, making it fast under the rope. The fleece, as a bundie, is easily carried about, having the clipped surface outside, which, being composed of white wool saturated with yolk, exhibits a shining silvery lustre. Fig. 332 represents a fleece

Fig. 332.



A FLEECE OF WOOL ROLLED UP.

of wool rolled up in the proper manner, where *a* is the wool at the breech forming the centre coil of the fleece, and *c* is the end of the rope made from the neck of the fleece twisted round its body, *b*.

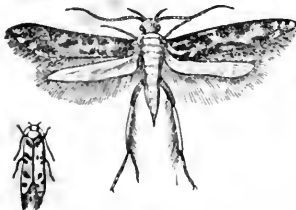
3938. Fleeces are not all alike, either in structure or colour. Those of ewes are thin and open in the locks, of pale colour, and feel light in hand. Hoggs' fleeces are close and long in the pile, of a rich colour, bulky,

and feel heavy in hand. All the fleeces are not in proper condition; an occasional fleece may want some part, having been shed off in the field; another may be coated, having a felted appearance, like a piece of very thick cloth; whilst others may have a dusky hue. Whenever such differences are observed, the fleeces should be laid aside, and sold separately.

3939. Coarse stray locks, and those clotted with dirt, should be put into a basket by themselves, to be afterwards washed, dried, and used at home for various purposes, such as in repairing the saddlery.

3940. Every day's clipping is carried into the wool-room, *w*, fig. 130, which is entered by a stair *c'*, from the straw-barn *s*. Previous to being occupied, the room should be swept clean of dust from its plastered walls, and its floor washed clean and dried. The fleeces are piled upon one another on the floor at a little distance from the wall, putting the hogg and ewe fleeces in separate divisions. Each division is covered with cloths, and the shutters of the window closed. The reason for these precautions, which are seldom attended to by farmers, is, that the cloths keep off dust, prevent too quick evaporation of the yolk of the wool, which, if allowed, will diminish its weight, and the exclusion of the light retains the bright lustre of the wool. A damp wool-room causes the wool to clap together and become moulded with a yellow mould. A very dry room scorches the wool. The odd fleeces and flocks should not be brought into the wool-room at all; the former should be sold, and the latter prepared for use immediately, as their unclean state creates such

Fig. 333.



THE WHITE-SHOULDERED WOOL-MOTH—*TINEA SARCITELLA*.

an efflu-
vium as will
induce the
w h i t e-
shouldered
wool-moth,
Tinea sar-
citella,
fig. 333,
to come
into the
wool-room.

This, as observed by Mr Curtis, "has long been recorded as a most mischievous little moth in our dwelling-houses, where it is common the greater portion of the spring, summer, and autumn. . . . The female deposits her eggs upon clothes, blankets, curtains, carpets, or any woollen articles, on which the larva feed, living in cylindrical cases which they form of the materials on which they subsist covered with their excrement, and in which they change to pupæ. The caterpillar is a lively wriggling animal, about half-an-inch long when full fed; it is soft and white, with a yellowish tint, and sparingly clothed with fine longish hairs, sometimes having a slate-coloured stripe down the back, arising from the food; the head is horny, of a chestnut brown, and furnished with little strong jaws and minute horns.*

3941. Wool is an unsafe article for a farmer to keep long. For a short time wool becomes heavier in the room, absorbing moisture from the walls, floor, and air, which it probably does as long as it retains its vitality; for, being a living body when shorn, some time must elapse before it loses its vitality entirely. After it has lost its vitality, it will soon lose its natural moisture in a dry room, occasioned by the yolk evaporating, when the fibres become curled and feel harsh. In a damp room, the absorption of moisture increases after the loss of vitality, and the fleeces become compressed, feel clammy, and affected with green and yellow mould. The wool-moth then takes up its residence in it in summer, and breeds numerous larvæ, which subsist on the fibres of the wool, and cut them in pieces. Many farmers have no proper wool-room, but keep their wool in the granary or in an out-house, where, of course, either of these effects are aggravated. The best way I know of preserving wool for a length of time is to keep it in a cool dry room having a wooden floor, packed in the pack-sheets, in which it will be out of the reach of dust, light, and moths. If only for a few weeks, it is best kept as directed in (3940.) The safest plan for the wool-grower is to sell it every year at the current prices, which are determined at the great wool fairs that take place in summer

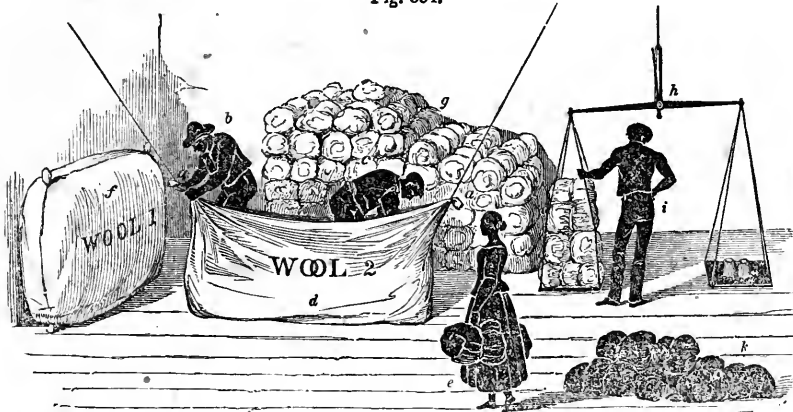
* *Journal of the Agricultural Society of England*, vol. vii. p. 429.

in every part of the country, either to the wool-dealers who attend there, or remit the entire clip of wool to a commission agent in Hull or Liverpool, to dispose of to the best advantage, at the proper time, to the wool-staplers, who assort each fleece into several portions, each portion being suitable to a particular manufacture. His object is to please the manufacturer, who will give the best current prices for the wool suited to his particular purpose. The mere wool-dealer purchases with the view of earning a profit on the fleeces in bulk. His object is to purchase at as low a price as he can bargain for.

3942. When a wool-merchant, of whatever sort, purchases wool from a farmer, he sends his own people to pack it in his

own pack-sheets. Wool is weighed in this way:—It is sold in Scotland by the wool-stone of 24 lb. avoirdupois, and is weighed out in double stones of 48 lb., each being called a *weigh*. Usually 7 Leicester hogg and 11 ewe fleeces make 1 weigh of 48 lb. In England, wool is sold by the lb., and weighed out by the *tod* of 2 stones of 14 each, or 28 lb. In weighing out, the above number of fleeces may not exactly weigh the double stone; and, as fleeces are never broken to equalise the scales, a few small weights are used to balance the scale either on the side of the wool or of the weights, at each weighing. In this way the weight of the number of weighs required to fill each pack is correctly ascertained, a memorandum being taken of each weighing. In fig. 334, is seen the large scales and beam *h*, used in weigh-

Fig. 334.



THE WEIGHING AND PACKING OF WOOL.

ing wool. The man *i* takes the fleeces from the pile *g*, and, after weighing the double stone, places the fleeces in a heap as at *k*. The wool-room should have as high a ceiling as to admit the suspension of the beam and scales from a hook; and if it is large enough to admit of the packing of the wool too in the sheets, so much the better; but if it will admit of neither of these conveniences, the wool must be removed out of it to the place where it is weighed, and where it must be placed on clean barn-sheets.

3943. Wool is packed in this way:—Pack-sheets are made of thin canvass, of the shape of an oblong rectangle, about 8

feet long when empty, and open along one side. A small stone is placed in each end of the opening of the sheet, and a rope for each end being suspended from the ceiling of the place where the wool is to be packed, the stones form knobs which prevent the corners of the sheet slipping through the tyings of the ropes, as at *a*, fig. 334. The sheet *d* is suspended just to swim above the floor. Two men, *b* and *c*, get into the sheet, place the fleeces, as handed to them by the woman *e*, from the heap *k*, lengthways *across* its bottom, as the man *c* is doing; and they trample them down with force, especially at the corners, where they are pushed down with both feet set together; while both hands hold

firmly by, and pull up the outside of the corner of the sheet immediately under the tying, as shown in action by the man *b*. The second layer of fleeces is laid contrary to the first, in length along the sheet, 2 or 3 fleeces being placed parallel in the breadth of the sheet: but the ends of the sheet are always filled with a fleece placed across its length, in the same position as at first, and pressed down in the same manner. The sheet is thus filled with alternate layers of fleeces to the top, when the packers come out of it, and then loosening the ropes, and reserving the small stones for the next sheet, immediately close the mouth of the pack; for, if left open for a time, the elasticity of the wool will cause the fleeces to rise so far as to render the closing afterwards impracticable, and a pack is difficult to close at all times. With the aid of hand-cramps, inserted into opposite sides, the edges of the pack-sheet are brought together, and so held by iron skewers passed through both edges. When a farmer is packing wool on his own account, it is well for him to know that common iron table-forks answer as well as hand-cramps for pulling, in opposite directions, the edges of a pack-sheet together, and for keeping them close like skewers. The edges being thus kept together, they are permanently secured by sewing with packing-needle and stout twine, and the skewers or forks are removed as the sewing proceeds. One pack is thus filled after another. A pack of wool *f* contains 10 stones, that is, 240 lb.

3944. Wool, as I have seen it packed in the Highlands, is not placed regularly in the sheet as I have described; the fleeces being crammed in and trampled down as they happened to come to the hands of the packer. The staple of the wool is sure to be broken by such treatment. I have seen Merino wool packed on a large scale at Leipzig. The sheets were made of horse-hair, and, in the packing, were occasionally subjected to the pressure of a long pole of wood acting upon them as a lever. The pole was fixed at one end by a ring to the ground, and heavy weights were suspended, and a rope fastened to the other end and passed through a ring in the ground, to keep good, by holding on, what the lever had gained. The wool was packing for Bri-

tain, to be conveyed in large waggons, each drawn by eight stallions, and to be shipped at Rotterdam.

3945. On the slightest inspection on the sheep's back, one can perceive that wool consists of different qualities, the coarser being evidently below and the finer above. The finest wool is upon the shoulder and along the top of the back to the rump; the next best is below the shoulders, along the ribs to the rump; the coarsest is on the haunches; and below the belly it is short and detached, and cannot be classed with the rest. Each of these parts have their respective qualities, which wool-staplers classify, in order to satisfy the wants of the manufacturers. The subdivision of the fleece by wool-staplers is technically in these terms:—Prime-lock—choice-lock—picked-lock—super-head—head—downrights—second abb—livery—short-coarse or breech-wool. It would be well for wool-growers to receive lessons from wool-staplers on the essential properties which constitute each of these practical subdivisions of the fleece, that they may be able to judge whether the wool they grow is useful or otherwise to the manufacturer; and if it is not, its value is sure to be depreciated in the market; for it is certain that, if the manufacturer cannot obtain in this country what he wants, he will go to other markets, and other countries. According to present practice, wool-growers grow wool without knowing whether or not it is fit for any sort of manufacture pursued in this country, and they must, therefore, take such prices as are offered.

3946. Good wool should have these properties:—The *fibre* should be of uniform thickness from root to point, when it is said to be *true*; the finer the wool, the smaller in diameter it is; it should be elastic, on being stretched longways; tough, not easily broken; its surface should have a shining silvery lustre; it should be of great density.

3947. Of a *staple*—the staple being any lock that naturally sheds itself from the rest—all the fibres should be of the same length, otherwise it will be *pointed*; the end of the staple should be as bright as the bottom, and not seem composed

of dead wool; the entire staple should be strong, and its strength is tested in this manner:—take the bottom of the staple between the finger and thumb of the left hand, and its top between those of the right, and, on holding the wool tight between the hands, make the third finger of the right hand play firmly upon the fibres, as in staccato on the strings of a violin; and if the sound produced be firm and sharp, and somewhat musical, the wool is sound; if the fibres do not break on repeatedly jerking the hands asunder with considerable force, the staple is sound; if they break, the wool is unsound, and it will break at the place which issued from the skin of the sheep when it was stinted of food or had an ailment—although it will not break at both those places simultaneously, because the part occasioned by the greater illness, being the weaker, will first give way. Pliability is an important property in the staple; inflexibility and brittleness are the opposite bad qualities.

3948. A *good fleece* should have the points of all its staples of equal length, otherwise it will be a pointy one; the staples should be set close together; and the fleece should be *clean*. A pointy, watery, or dirty fleece creates much waste to the manufacturer, to bring a portion of the wool to the proper state. An essential property of a fleece is its *softness* to the feel, which does not depend on *fineness* of fibre, but on a peculiar sort of elasticity which yields to the touch at once, and readily recovers the form it had. There should be no *hairs* in wool, no long ones, which are easily distinguished from wool, and give the name of *bearded* to the fleece; nor short ones, soft and fine, like *cat's hair*, which are not easily distinguished from wool, and are named *kemps*. The long hairs are frequently of a different colour from the wool, but the kemp hairs are of the same colour; and of the two, the latter are the more objectionable, as being less easily detected.

3949. Keeping all these properties in view, the farmer who breeds sheep having fleeces with pointy staples, thinly set on, and of unequal lengths—who stints his sheep of food at times, producing wool of unequal size—and who does not wash his sheep clean—or, having washed them clean,

allows their wool to be dirtied before being clipped, injures his clip of wool to a serious extent.

3950. Attention by farmers to the different classes of wool required by the various manufacturers of woollen goods, might direct them to produce wool in every locality best suited for a particular manufacture. Our manufactures seem to require three classes of wool, which possess distinct characteristics—one for carding, another for combing, and a third intermediate to these.

3951. *Carding* wool should be short, under four inches in length, fine, true, very elastic in its length, and crumple up when let go. The object of carding is to break the wool completely, to blend it most intimately, so as to form it into a thin roll of the slightest texture, held together only by the natural hookedness of the pile, which disposes it to assume a zigzag or waved form. Wool that will bear this process is fit to be manufactured into the finest fabrics, with a close and smooth surface. The waying and crumpledness is not any sort of curvature which disposes the fibres into parallel curves, that seem as if they had been formed by external pressure, but is produced by a natural cause affecting every individual pile as it passed through the pores of the skin, causing one pile to hook on to its neighbour.

3952. *Combing* wool must be more than four inches long, fine, true, but little elastic in length, and each pile ready to arrange itself in parallel spirals with its neighbours. The comb has not only the effect of laying every pile straight and even, and of removing the shorter piles than the generality of the fleece, but also the few longer ones which may happen to be tied together in indissoluble knots. Combed wool spins into the worsted which makes all the finer class of worsted goods.

3953. The distinction in the spinning of the carding and combing wool is thus well described by Mr Luccock:—"In twisting a woollen thread," he says, "when the staple has been previously broken, and the fragments of it in the utmost disorder, they are united only by their natural hook-

edness, and the turning of the wheel rolls them together without arrangement, and they are placed in every possible direction. But in spinning a worsted thread, where every hair has been previously disposed by the side of others in the most regular order, the pile is drawn out in the direction of its length, every single hair being parallel to all those which lie near it, and is twisted in a spiral form, something like the threads of a compound screw. If these hairs contracted their length to any considerable degree, they could not be correctly arranged, nor drawn out in that regular order which the work requires, but would be twisted into the thread in an irregular and crumpled form—a circumstance injurious to worsted yarn, and to the goods which are made from it.”*

3954. Intermediate to the short and long wools, is that chiefly employed in the hosiery manufacture. This manufacture takes wool from four to eight inches long, which has contracting properties in too great a degree and are too weak for the comb, and are as elastic and longer than the short wools, but too coarse for the finer classes of goods.

3955. The geographical distribution of the sheep in Great Britain, which produce these three classes of wool, is pretty distinctly marked. The E. coast more than the interior and the W. coast, and all the richer lands in the courses of the rivers flowing chiefly to the E. coast, are inhabited by the sheep which yield long wool. The green, half-elevated grounds, which lie between those river courses, support the fine short-woolled sheep; whilst the highest ranges of pasture produce the coarse wool.

3956. The Leicester, Lincoln, Cotteswold, and Kent breeds of sheep produce long wool; and little long wool is imported. The Cheviot, Norfolk, Wiltshire, Western, Hereford, and Southdowns, produce short wool, and much short wool is imported. The Merino wool, which is short and fine, is imported from Spain, Saxony, and Australia, in large quantities. The Black-faced and Welsh breeds produce coarse short wool; and of this quality

a considerable quantity is obtained from abroad.

3957. In regard to the cause of the fineness of wool, Mr Culley remarks, that “the Herefordshire sheep that have the finest wool are kept *lean*, and produce $1\frac{1}{2}$ lb. each; if better kept they grow larger, and produce more wool, but inferior in quality.”† This is true of every breed of sheep, and particularly of the Merino, whose *propensity to leanness* caused their culture to be abandoned in Britain as unprofitable. Their wool did not so much deteriorate in this cold climate, as the impossibility of getting mutton upon their carcass. But though leanness may produce wool of finer quality than high condition, yet the remark is only strictly true when applied to breeds which yield fine wool in all conditions; for no degree of leanness will cause a coarse-woolled breed of sheep, such as the Black-faced, to produce *fine* wool. To obtain a given quality of wool, therefore, it is necessary to possess the breed that produces it, and the wool may be comparatively finer or coarser as the sheep may be kept in low or high condition. But I apprehend that the fineness of the pile of wool depends chiefly on the fineness of the pores of the skin of the animal, and this probably depends on the fineness of the breed—but of those breeds, of course, which produce fine wool. There is no doubt, however, that the quality of the wool of this country is coarser than it was years ago; not because the breeds of sheep have deteriorated—on the contrary, they have all improved—but because the animals are kept throughout the year in much higher condition than they were; and such a result might have been anticipated, for a high condition, indicating a moist skin, should cause its pores to enlarge. During the improvement that has taken place in the breeds of sheep, the counteracting influence of shelter, as I conceive, has been at work to retain the wool of finer quality against the effects of high condition; and though shelter, by preventing unequal evaporation of the yolk of the wool, by warding off cold and drying winds, only exercises a negative influence, yet its effects are positively beneficial, inasmuch as Mr Lucecock observes, that “the silky softness, like most other good qualities of the fleece, depends very much upon the breed of the sheep, and the quality of the yolk which they constantly afford.”

3958. It is not easy to determine whether the *density* of the fibre of wool, that most desirable property, depends on some general law connected with the breed, or the circumstances in which the fibre is produced, since the mere coarseness or fineness of the fibre does not affect its specific gravity: as, for instance, the close full-grown wool on the shoulder of a sheep does not differ materially, in density, from that of the thin and hairy breech; and hence, perhaps, the density does not depend on the breed. I am inclined to believe that soil and food very much affect the weight of wool, for we find what is grown in the chalky districts of England much drier and

* Lucecock *On Wool*, p. 154, edition of 1805.

† Culley *On Live Stock*, p. 132—note.

lighter than wool produced on fine soft hazel loam; and that grown from turnips appears to me heavier than wool from grass of the same soil. This fact is undeniable, that fleeces from the same breed, reared in similar circumstances, differ much in density. The conclusion to be inferred from all these considerations seems to be, that whatever induces the greatest secretion of yolk, whether it be breed, condition of animal, nature of soil, or food, will produce fibre of the greatest specific gravity; and hence on grass on a deep mellow soil, in good heart and in a sheltered situation, a fine breed of sheep, capable of continuing in good condition *throughout the year*, should produce the densest, the finest, and the longest fibre of wool. If these views be correct, you easily perceive how much depends on the judgment of the farmer 'to produce wool possessing the greatest number of good qualities.

3959. The late Mr Youatt examined the external structure of wool with the microscope, and ascertained that the surface of the fibre is covered with scales which form a series of serrations along its entire length. The general outline of the fibre consists of a central stem or stalk, probably hollow, or at least porous, and the stem possesses a semi-transparency not found in the fibres of hair. From this central stalk springs at distances, in all the breeds of sheep, a circlet of leaf-shaped projections. Thus wool possesses a property common to all independent horny fibres which issue from the skin of animals, an irregularity which constitutes a degree of roughness upon the surface from the root to the point. Hence, both physically and chemically, wool and hair are analogous substances.

3960. The comparative fineness of the pile of wool of the following breeds of sheep, was measured by Mr Youatt with the micrometer:—

	Diameter of one inch.	Serrations in the inch.
Merino wool, . . .	$7\frac{1}{8}\sigma$	and 2400
— Picklock, . . .	$7\frac{1}{8}\sigma$	... 2560
— Saxony, . . .	$7\frac{1}{8}\sigma$	... 2720
Leicester, . . .	$7\frac{1}{8}\sigma$	... 1860
Deccan, black, . . .	$7\frac{1}{8}\sigma$	... 1280
Odessa, . . .	$7\frac{1}{8}\sigma$	... 2080
Wallachian, . . .	$7\frac{1}{8}\sigma$	... 2080
Australian, . . .	$7\frac{1}{8}\sigma$	... 1920
New South Wales, . . .	$7\frac{1}{8}\sigma$	... 2080
— Mr Arthur's, . . .	$7\frac{1}{8}\sigma$	... 2400
Van Diemen's Land, . . .	$7\frac{1}{8}\sigma$	... ..
Southdown, . . .	$7\frac{1}{8}\sigma$	... 2080
Wiltshire, . . .	$7\frac{1}{8}\sigma$	... 1860
Ryeland, . . .	$7\frac{1}{8}\sigma$	... 2420
Chievot, hill-fed, . . .	$7\frac{1}{8}\sigma$	... 1860
— good pasture, . . .	...	... 1440
Norfolk, . . .	$7\frac{1}{8}\sigma$	... 1600
Lincoln, . . .	$7\frac{1}{8}\sigma$	... 1280
Irish, . . .	$7\frac{1}{8}\sigma$	... 1920*

3961. A correct instrument, named the eiro-

meter, the invention of the late celebrated optician, Dolland of London, reads off diameters of a very minute fraction of an inch, and may therefore be used for measuring the diameters of wool. It produces a double image of the fibre, which, on being brought in contact, the result is read off a circular index. The cost of this instrument is about £2, 2s.

3962. M. Raspail ascertained the manner of the growth of wool by means of the microscope. "If the fetus of a sheep," he observes, "taken when it is of the length of about $4\frac{1}{2}$ inches, and preserved in alcohol, be examined, it will be found studded with globules of uniform size, elegantly arranged, and almost at equal distances, round certain white spots disposed in quincunxes, which seem, even at this early period, to indicate the places where the hairs are to grow. On the epidermis of the temple, instead of thin white spots, we find vesicles projecting in the form of bottles, or rather of urns, whose sides are granulated in the same manner as the epidermis. These vesicles are the rudiments of hairs."† The organic difference in the origin of hair and of wool is thus distinctly indicated.

3963. Wool is well known to have the power of becoming felted. This quality is not evident to the eye, and the best judges of wool consider this to be a point only to be ascertained by trial. It consists of a tendency in the pile, when submitted to moderate heat, combined with moisture, to cohere together, and form a compact and pliable substance; and pressure serves to make the contact the closer, by excluding the air from between the interstices of the fibres. The proceedings of nature in the operation of felting are little known. A coated fleece is a natural instance of the felting property of wool. Mr Youatt believes that the discovery of the serrations on the fibre of wool accounts for its felting property. "It is a curious and interesting point that has been established," he says, "the existence of an irregularity of form in the wool accounting for, and necessarily giving it a felting power—is there a variation in this structure corresponding with the degree of felting power?" Mr Boyd, woollen manufacturer, of Innerleithin, Peeblesshire, questions Mr Youatt's views. "Mr Youatt asserts with much confidence," he remarks, in which he is supported by Mr Luccock, "that the felting properties depend entirely on the structure of the wool. During an experience of many years, I have found this not to be the fact, and therefore state, without fear of contradiction, that in many instances it is impossible to estimate the extent of the felting properties in a variety of wools, until they have been submitted to the actual test of experiment; and I am decidedly of opinion, that however perfect the structure of wool may be, if produced in the absence of an oily or saponaceous substance, it cannot possess the requisite properties of a clothing material."‡ Mr Boyd is again supported by Mr Luccock, when he says, "If

* Youatt *On Sheep*, p. 91.

† Raspail's *Organic Chemistry*, p. 283.

‡ *Prize Essays of the Highland and Agricultural Society*, vol. xiv., p. 669.

the wool-grower be anxious to promote the growth of fleeces prevailing in the felting quality, I should recommend, from the little knowledge at present possessed, that he should promote the supply of the rich and nutritious yolk, which the pile receives while growing."

3964. Mr Youatt's theory appears to me unsatisfactory. On the authority of Mr Luccock, the application of *moisture, warmth, and pressure* are necessary to bring the felting property of wool into action. "Without the aid of moisture," he affirms, "it remains perfectly dormant; the warmth and pressure are required to quicken the process." And he adds, "The degree of heat required to make the felting property act with the utmost force, is considerably below the boiling point of water," and that "a higher temperature loosens the texture of the thread, and increases the elasticity of the hair, thus giving it a disposition to start from the substance of the cloth, and spoil its surface." If the serrations of the fibres be the principal means of felting wool, it must be proved that they change their structure on being immersed in water at a temperature near the boiling point, which has not yet been done. Wool, after being combed with heated iron combs, will not felt; and yet the number of serrations given by Mr Youatt, do not warrant us in believing that, with any number of serrations, one wool shall felt, and another with the same number shall not felt. For example, the table informs us that Leicester wool gives 1860 serrations in the inch; and it has no felting property, being an excellent combing wool. It also informs us that Cheviot wool gives only the same number of serrations, 1860, and yet it is one of the best felting wools known; while the Southdown gives as high as 2080 serrations in the inch, and it is not a good felting wool.

3965. "Felting," observes Mr Luccock, "is the basis upon which the hat manufacture depends among ourselves, and has for many ages been applied abroad to the production of pieces of domestic furniture. In the fabrication of worsted goods it is not employed; nor is it necessary in the manufacture of stockings, blankets, baize, flannels, nor any other article not submitted to the action of the fulling mill. In some of them, when made of wool in which it abounds, the housewife finds great inconvenience, and complains that her stockings and her flannels become too small for the wearer. From the different modes of manufacturing these articles, we may conclude that, in general, the felting quality is a valuable one in almost every description of fine and short-stapled fleeces, and that it is not desirable in the greater part of the longer and coarser wools."

3966. The nature of the soil seems to have an effect on the felting property of wool. The fine short wool of the Southdown and Wiltshire breeds, do not felt well or easily, owing most pro-

bably to the effect upon it by the calcareous soils abounding in those districts, for when those sheep are removed to different soils, they produce a wool which thickens in the fulling mill, although the process proceeds more slowly than in some other breeds. We must not conclude from this circumstance that the difference observed in the felting quality of fleeces is entirely owing to the land, because we find upon soils known not to be injurious to wool, different kinds of sheep whose fleeces do not felt in an equal degree.*

3967. I have mentioned the calculated number of sheep in the kingdom (3603.) Taking that as the basis, Mr M'Queen calculates the quantity of wool they produce at the following rates:—

19,800,000 long-woolled sheep at 7½ lb. =	143,000,000 lb.
28,200,000 short " " 3½ lb. =	98,700,000 lb.
<hr/>	<hr/>
48,000,000	241,700,000 †

The pack containing 240 lb. of wool, this quantity will fill 1,002,791 packs.

3968. Mr Porter states that the late "Mr Hubbard of Leeds, a gentleman of great experience in the wool trade, expressed his belief before the committee of the House of Commons, in 1828, that the actual number of sheep in England and Wales had increased one-fifth since 1800; and that the long-woolled sheep had become more numerous than the short-woolled, and that the weight of the fleece had so much increased that, one with another, each sheep yielded more than 5½ lb. of wool."‡ It will be observed that the relative number of long and short-woolled sheep, as given by Mr M'Queen, in the foregoing table, (in 3967,) does not coincide with the statement of Mr Hubbard, though the average weight of each fleece does so exactly.

3969. Taking the price of long wool at 1s., and of the short wool, coarse and fine, at 9d. the lb., the quantities specified in (3967) will bear these values:—

143,000,000 lb. at 1s.,	£7,400,000
98,700,000 lb. at 9d.,	3,701,250
<hr/>	<hr/>
241,700,000	£11,101,250

3970. The quantity of sheep and lamb wool, including that of the Alpaca, Llama, and Vicuña, imported into the kingdom, duty free, in 1847, was 62,592,598 lb., and in 1848, 70,521,957 lb.

3971. The declared value of wool and woollen manufactures, exported from the kingdom, was—

	1847.	1848.
Wool, sheep's and lamb's,	£288,231	£189,817
Woollen yarn,	1,001,364	776,175
Woollen manufactures,	6,896,028	5,740,634
<hr/>	<hr/>	<hr/>
	£8,185,633	£6,706,626 §

* Luccock *On Wool*, p. 161-4.

‡ Porter's *Progress of the Nation*, p. 175.

† M'Queen's *Statistics of the British Empire*, p. 52.
§ *Parliamentary Return*, Feb. 26, 1849.

3972. To show the importance of the home market to the woollen manufactures, I shall state, keeping the amount of exports as above in view, that in the committee of the House of Commons in 1823, it was stated by Mr T. Elworth that four-fifths of the woollen goods made were worn at home; by Mr Henry Hughes, that three-fourths were worn at home; by Mr G. B. Hall, that in washing wool loses 10 lb. in 20 lb.—that it takes 4 lb. of unwashed wool to make one yard of broad cloth, price 18s.; by Mr J. C. Francis, that it requires 2½ lb. of wool to make one yard of cloth, value 10s.—that the manufacturing costs 5s. the yard; and by Mr Benjamin Gott, that the price of manufacturing a yard of cloth was equal to the value of the wool.*

3973. "A curious trade," observes Mr Porter, "has of late years been introduced—that of importing foreign woollen rags into England for the purpose of re-manufacture. These are assorted, torn up, and mixed with English, or more commonly with Scotch wool of low quality, and inferior cloth is made from the mixture, at a price sufficiently moderate to command a sale for exportation. By this means a market is obtained for wool of a very low quality, which might otherwise be left on the hands of the grower.†"

3974. When the skins of the Cape sheep are properly dressed and cleaned, and a number of them sewed together, they form a much warmer covering than could be made from any other materials. The richer inhabitants, and those of Cape Town, who can afford themselves more expensive coverings, affect to dislike this cheap article, because they say it smells of mutton; but the boor, the Cape farmer, is enabled by his immense flocks to select such only as have a smooth fur, and so he obtains a handsome coverlet, so unlike what a European could imagine, from sheep's skins, that it may be doubted whether many persons could even guess from what animal it was made. Those that have been brought to Europe, have been viewed as the skin of some unknown quadruped. Few furs can be more beautiful than the selected skins of lambs thus prepared.‡

3975. The term *merino*, denominative of a particular breed of sheep and kind of wool, is of obscure origin. Mr Southey informs us, that "Merino is an old Leonese title, still preserved in Portugal, though long since obsolete in the other kingdom of Spain. Perhaps it is a mongrel diminutive of the Arabic title *mir* or *emir*, likely enough to have been formed when the two languages, Spanish and Moorish, were, as it were, running into each other. *Mirquebir*, the augmented title, was in use at Ormuz. *Merino* would be sufficiently explained by supposing it a diminutive grade. The old laws of Spain define it thus:—"He is a man who has authority to administer justice within a certain district." The first mention of this office is in the reign of Bermudo II. The Merinos then commanded the

troops of their respective provinces in war; but, before the time of Henrique II., it was become wholly a civil office, and the title was gradually giving place to that of Alguacil, (mayor.) Most probably the judge of the shepherds was called the merino, and hence the appellation extended to the flocks under his care."

3976. It is the common opinion that merino sheep came to this country from Spain, and so they did in the end of the last century, but it appears that *fine-woolled* sheep were sent from England to Spain a much longer time ago. That sheep were sent from England to Spain at a known period is certain, for Mr Youatt quotes from the Chronicles of Stowe, that "this yere (1464) King Edward IV. gave a license to pass over certain *Cotteswolde* sheep into Spain;" and he quotes Baker also, who says, "King Edward IV. enters into a league with John, King of Arragon, to whom he sent a score of *Costal* ewes and four rams—a small present in show, but great in the event, for it proved of more benefit to Spain, and more detrimental to England, than could at first have been imagined." The wool of the *Cotteswolde* sheep of the present day is long, and not remarkable for fineness. Perhaps the old *Cotteswolde* wool was finer than that of the present period, because that breed of sheep has been much crossed with the Leicester. But if the old *Cotteswolde* conferred so much benefit on Spain, it may be fairly inferred that the wool of Spain was not so fine as that of England at the time. But sheep were exported from England to Spain prior to the reign of Edward IV., as Mr Southey intimates, that "Fernan Gomez de Cibdareal, in one of his letters. (Epist. 73.) mentions a dispute between two Spaniards concerning rank in the presence of Juan II., 1437. It was objected tauntingly to one of them, that he was descended from a judge of the shepherds, that is, from a merino. The reply was, that this office had always been held by hidalgos of great honour, and that 'King D. Alfonso had instituted it in the person of Inigo Lopez de Mendoza, when the *English sheep were first brought over to Spain.*" This dispute occurring in 1437, and referring to an ancient title of honour, which had been conferred as far back as the time of the introduction of English sheep into Spain, and a taunt being then also given to a descendant of a Merino, it is clear that the English sheep referred to could not have been the *Cotteswoldes* exported in 1464, as mentioned by Stowe. "How long was it before the merino fleece became finer than that of the original stock?" asks Mr Southey; and he replies, "Brito, who wrote towards the close of the sixteenth century, says in praise of the wool grown about Santarem, it is so fine that *it may vie with that of England, (Monarchia Lusitania, f. i. p. 93.)* If the Spanish wool had been as fine then as it is now, he would hardly have drawn his comparison from the English."

3977. While these facts are recorded in Spanish literature, regarding the origin and ancient quality

* McQueen's *Statistics of the British Empire*, p. 54. † Porter's *Progress of the Nation*, p. 177.

‡ Bischoff's *History of Woollen Manufactures*, vol. ii. p. 292.

of the wool of Spain, the opinion of Mr Youatt seems much too strongly expressed, when he says, that "Europe and the world are originally indebted to Spain for the most valuable material in the manufacture of cloth." And again, "The chunahs, therefore, may be descendants of the English sheep," namely, those sent to Spain in 1464, "mixed with the common breed of the country; but farther than this England cannot, with any degree of justice, urge the claim which some have done, of being instrumental in producing the invaluable Spanish wool."* And yet, as we have seen, sheep were probably sent from England to Spain long before that date, or even long before 1437; for if the King Alphonso mentioned above, as having instituted the order of judge of the shepherds, be Alfonso the Wise, king of Leon and Castile, who is stated to "have digested a code of excellent laws, and rendered his name famous in history by his patronage of the arts and sciences,"† he reigned at the early period from 1252 to 1284. Another fact mentioned by Mr Southey is, that when Catharine, daughter of John of Gaunt, was espoused to Henrique III., she took English sheep with her as her dowery, which fixes another exportation of sheep to Spain about 1390—a considerable time prior to the Cotteswolde exportation of 1464; and if the English sheep had been of an inferior description to those of Spain, it is not likely that the future Queen of Castile would have taken them with her for her own dowery.

3978. Mr Southey puts the query: "Can there possibly be any truth in the remark of Yepes (t. 7, § 134,) who says, 'Daily experience shows us, that if a lamb is suckled by a goat, the wool becomes hard and hairy; and, on the contrary, if a kid is suckled by a ewe, the hair becomes soft?'"‡

ON THE SUMMER CULTURE OF BEANS.

3979. The state we left the bean crop in spring, in (2443,) was immediately after the drills had been harrowed down on the crowns with the drill-harrow, fig. 220, about a fortnight after the crop had been sown. So soon as the young plants growing on raised drills (2432) have attained two or three inches in height, the scuffler, fig. 262, should remove all the weeds that may have appeared between the drills in the interval of time since the drill harrowing; and the scuffling will also reduce some of the clods, where the land is naturally tender. The field workers follow the scuffler with the hand-hoe, fig. 266, and remove all the weeds growing along each side of the plants, and pull those by the

hand growing between them, and displace such clods as are seen to interfere with the proper growth of the plants. The workers should be careful in using the hoe amongst bean plants, as they are very tender and easily bruised and cut over. After the plants have risen about a foot in height, which they will soon do in favourable weather, the blossom will begin to appear; and its appearance should be the signal to finish the work amongst this crop as soon as possible. Time may be found to drill-grub, fig. 264, the space between the drills, and hoe the sides of the drill along the plants; but if not, the double-mould-board plough, fig. 214, should at all events, as the last operation, set the earth well up to the roots of the plants, in order to give them a firm footing on the top of the drill against the power of the wind.

3980. The summer culture of beans growing on the flat ground in rows (2431) is the same, in as far as the scuffling, hoeing, and drill-grubbing the ground are concerned, as on the drill; but the land is not set up with the double-mould-board plough, the drill-grubbing finishing the operation.

3981. When beans are grown broadcast, (2414,) no implement but the hand-hoe is of any avail in clearing the ground of weeds; and as the hand-hoeing would require to be performed much oftener than time will allow, to keep the ground as clean as it should be, the inevitable consequence is that a crop of broadcast beans is always a foul one, unless the weather is so favourable, from the earliest part of the season, as to push the bean plants as far forward as to smother the weeds by overgrowing them.

3982. In England, the young bean plants are subject to be eaten down in moist weather by the common field slug, *Limax agrestis*.§ I never heard of this mollusc being so numerous in Scotland as sensibly to affect a field crop, although the small grey slug, *Limax cinereus*, is troublesome enough at times on plants in the garden.

3983. In dry summers, the young stalks

* Youatt *On Sheep*, p. 146-7.

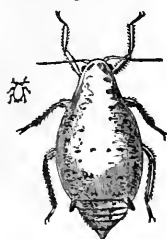
† Bigland's *View of the World*, vol. ii. p. 589.

‡ Southey's *Omniana*, vol. ii. p. 103-8.

§ Macgillivray's *Molluscous Animals of Scotland*, p. 43.

and leaves of the bean are attacked by the *Aphis fabæ*, commonly called the black

Fig. 335.

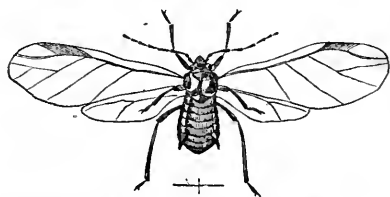


THE WINGLESS FEMALE
OF THE BEAN PLANT-
LOUSE—APHIS FABÆ.

dolphin, and collier. The females, fig. 335, are apterous, ovate, sooty black. When this aphid appears, it does so, like all its tribe, in countless numbers; and from their numbers they commit, in a few days, extensive ravage upon the leaves and tender stalks of the bean. The only

course that can be practically adopted to get the better of them is, that, as they cluster chiefly on the topmost bunch of the leaves, these should be cut off with a sickle, which the field-workers can do very quickly, and by this means the propagation of the pest may be prevented. But it is not sufficient to cut off the tops of the bean plants and let them lie on the ground, for the aphides will again remount the bean plant—or at least the males, fig. 336, which are

Fig. 336.



THE WINGED MALE OF THE BEAN PLANT-LOUSE—
APHIS FABÆ.

winged and black, when they are hatched, will escape. The tops cut off should be carried to the ends of the drills and burned, or deep holes dug in the headridges, and the tops buried in them with quicklime. It is doubtful where these aphides are bred in the egg—it cannot be upon the bean plant, and as they are at first apterous, they cannot transport themselves. The lady-birds, fig. 275, destroy this aphid.

3984. The flower of the bean is often deprived of its prolificacy by one of the humble bees, *Bombus terrestris*, which is densely clothed with the finest hairs of the deepest black. Although bees are useful in assisting in the fecundation of plants, when the female earth-bee is too large to

creep into the flower to reach the nectary, she pierces the exact spot of the calyx, as well as the upper lobe of the flower, beneath which the nectar is stored, and the extraction of nectar is a great detriment to the crop, which cannot then perfect all the beans in the seed-pod.* The most formidable foe to the humble bee is the caterpillar of the moth called *Ilythia colonella*, which feeds upon the honey, and, when full fed, spins a web of a close woolly texture, so tough that it cannot be rent in pieces. The moth creeps into the nest in June to deposit her eggs, and the caterpillars live in families sometimes of 500, to the total destruction of the poor humble bees.

3985. Beans often sustain serious injury from the attacks of a small short-snouted weevil, of the genus *Sitona*. It was particularly abundant in 1848, and we have seen young bean-plants almost wholly stripped of their leaves by it. There are numerous species, but the two which appear to be most injurious in Scotland, are *S. ulicis* and *S. canina*. The beak is short, and nearly flat above, and has a groove down the middle; the body covered with small scales of a brownish colour above, and ash-grey beneath; there are three pale lines on the thorax, and the wing-cases are deeply punctured in linear rows; in *S. canina*, the latter are likewise marked with pale lines. These insects attack the bean shortly after it appears above the ground, and continue to frequent it during the greater part of its growth. But they by no means confine their depredations to that plant, but feed on almost all the leguminous species, and are often very hurtful to young pease both in gardens and in the field. Sweet pease in gardens seldom fail to be disfigured by them, in the earlier stages of their growth.

3986. After the bean-plant has grown until all the pods are set, the practice of the garden indicates that, when the top of the plant is cut off in moist weather, at that period of its growth, the crop will be sensibly increased. This is a probable result, it being a common observation that, in moist weather, the bean has a great tendency to grow in height long after the pods have ceased to form; and as long as this

* *Journal of the English Agricultural Society*, vol. vii. p. 413-16.

tendency continues, the pods and beans do not enlarge; and the only mode of checking the tendency, in the circumstances referred to, is to cut off the top, when the vigour of the plant's growth will of course be directed to the nourishment of the fruit.

ON THE SUMMER CULTURE OF PEASE.

3987. Although the most common practice is to sow pease along with beans (2454,) yet, as they are also cultivated alone, it is necessary to bestow attention on them when they are so cultivated. When sown broadcast, the pea-plant, growing quickly, especially in moist weather, soon overcomes the weeds that may be disposed to grow along with it; but, though it overcomes them, it does not entirely destroy them; and the consequence is, the ground is left by the pea, when sown alone broadcast, in a foul state. When sown in rows, in every third furrow of the plough, or in drills, (2456,) at 27 inches apart, the ground may be scuffled, fig. 262, hoed, fig. 266, and drill-grubbed, fig. 264, the same as beans are when sown in rows in the flat, (3980.) These operations will require to be rapidly performed, since the quick and straggling growth of pea-straw affords neither time nor room for dilatory work, and as much should be done in the time as the circumstances of the case will admit.

3988. The pea-plant is subject to the attacks of many insects. The little brown pupæ of the fly *Phytomyza nigricornis* feed on the parenchyma, or pulp of the leaf, causing minute brown specks on the leaf.

3989. A more formidable enemy is the striped pea-weevil, *Sitona lineata*, fig. 337, which represents the insect greatly magnified, as may be seen by comparing the figure with the line alongside of it in length of the natural size. This weevil is more or less ochreous, or light clay colour, elliptical in form, and convex above, punctured and covered with minute scales; and, when these are worn off by age or accident, the beetle has a black shining surface: it has two strong mandibles for biting, notched on the inside; eyes lateral,

prominent, orbicular, and black; below them, on each side, is a deep angular groove

Fig. 337.



THE STRIPED PEAWEEVIL—*SITONA LINEATA*.

to receive the two antennæ, inserted towards the tip of the nose; thorax deeply punctured, broader than the head towards the base; tarsi four-jointed, and all combined beneath except the fourth, which is long, clavate, and terminated by two small claws. The numbers of this beetle are at times very great, while the art it displays in eluding detection is very remarkable. On a person going into a crop of peas infested by it, a pattering like rain may be heard upon the leaves, occasioned by the numbers dropping down to the ground, where they fall upon their backs amongst the clods, and remain motionless, with their legs folded up. They perfectly riddle the leaves of the pea. They affect the leaves of the lucerne and red clover, as well as those of the pea. They begin at the edge of the leaf, holding it steadily between their legs, whilst they eat down from the top to the bottom. On the clover being moved by hand or foot, they will fall off by dozens to the ground, where they remain concealed for a time.

3990. The pea itself suffers from a beetle named the pea-beetle, *Bruchus pisi*. "The beetles pair in summer," says Mr Curtis, "whilst the peas are in flower and producing pods; the females then deposit an egg in almost every pea which has just formed. From the outside of these peas, when arrived at maturity, they do not appear damaged; but, on opening them, one generally finds a very small larva, which, if left to repose, remains there all the winter and part of the following summer, consuming by degrees all the internal substance of the pea, so that in the spring the skin only remains; after which it is transformed into an insect with scaly wing-cases, which pierces a hole in the skin of the pea, from whence it comes forth and resorts to the fields sowed with that pulse, in order to deposit its eggs in the new pods."* This insect is about 2

* *Journal of the English Agricultural Society*, vol. vii. p. 408, 419, 428.

lines in length, but fortunately it is rare in this country; but another species, *Bruchus granarius*, is rather plentiful in peas and beans, stored in granaries as well as in those imported from abroad, particularly from Odessa. Worm-eaten peas are ascribed by some to the larva of a saw-fly, whilst others affirm it is that of a moth, whose metamorphoses are as yet unascertained, and a *Bruchus* gets the blame from other parties. It would seem, from this contrariety of opinion, that the insect which commits the ravages has not yet been detected in the perfect state. The caterpillars of the white-shouldered woolen moth, *Tinea sarcitella*, fig. 333, are found in the cavities of peas and beans which had been occupied by the *Bruchus*. These caterpillars spin their webs in the texture of the sacks which contain peas or beans; and so closely are the threads of the sacks agglutinated together by their webs, that the strength of a man is required to tear them asunder. No doubt dampness and mouldiness assist the efforts of those caterpillars.

3991. The pea crop is very subject to mildew when the ground is dry, and the air moist and cool—an unfavourable state for vegetation in summer. It exhibits itself upon the leaves of the plants, and as long as it remains their functions seem suspended—the stem and leaves make no progress in growth, and the blossom and grain are diminutive. Rain washes the mildew off, and the plant regains its ordinary hue, but never attains the size and health it would have enjoyed had it not been attacked by the mildew.

3992. Mildew is a fungal plant, parasitic upon organised matter, and is valuable in the economy of nature by assisting in the decomposition of decaying or decayed animal and vegetable substances. It originates in sporules so minute as to elude observation by the naked eye. Some kinds of mildew live entirely under the scarf skin of the plants they inhabit; whilst others exist in the open air, but all live at first beneath the epidermis, and not upon it.* When the fungal affections of plants are of a white colour they are called *mildew*, in the agricultural sense, and when of red or brown colour they are named *rust*

in that sense. These distinctive appellations are natural, and characteristic as to their appearance. "The secondary and immediate causes of this disease," observed the late Mr Knight, "have long appeared to me to be the want of a sufficient supply of moisture from the soil, with excess of humidity in the air—particularly if the plants be exposed to a temperature below that to which they have been accustomed. If damp and cold weather in July succeed that which has been warm and bright, without the intervention of sufficient rain to moisten the ground to some depth, the crop is generally much injured by mildew."† These remarks explain the cause of the appearance of mildew in the pea with sufficient accuracy, and, acting in their belief, Mr Knight was enabled to ward the disease off his pea crops. The white mould on the pea is a species of *erysiphe*. "All fungals absorb oxygen, and exhale carbonic acid. This has been proved experimentally by Dr Marcet of Geneva, and may account for their tendency to vitiate the air, instead of purifying it as other plants do; and it may also explain the cause of the fungi being so universally destitute of green colouring matter, which is known to result in other plants from the decomposition of carbonic acid. Fungals abound in nitrogen. Certain fungi, in an imperfect state, are said to be connected with fermentation. The curious circumstance that in certain bake-houses the bread becomes ropy, and, though sometimes prevented from assuming this condition by repeated washings of the walls and floor with chloride of lime, the evil is occasionally so obstinate as to prove the ruin of the establishment, is probably dependent on the same cause. Another curious circumstance is, that mouldiness is effectually prevented by any kind of perfume. It is known that books will not become mouldy in the neighbourhood of Russia leather, nor any substance, if placed within the influence of an essential oil."‡

ON THE WEANING OF LAMBS.

3993. Many of the older lambs wean themselves after their mothers have been shorn of their wool. Whether it is that

* *Journal of the English Agricultural Society*, vol. ii. p. 2-11.

† Knight's *Horticultural Papers*, p. 206.

‡ Lindley's *Vegetable Kingdom*, p. 41.

they do not recognise their mothers, from the altered appearance they have on being deprived of their fleece, or whether the scent of the body is lost or changed by exposure to the air from want of the fleece, it is not easy to determine; but, be the cause what it may, the event may be looked for by the shepherd of several of the oldest lambs weaning themselves from their mothers, immediately after these shall have been clipped. The voluntary weaning is no loss to the lambs, since, up to the period of clipping, they had almost solely depended on the grass for subsistence.

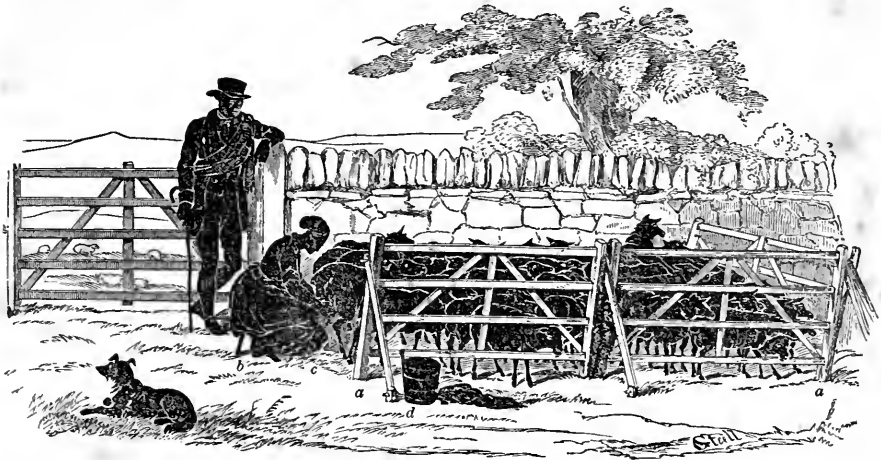
3994. Leicester lambs are weaned at the end of June or beginning of July; and the process is simple and safe, as most of them by that time chiefly depend upon grass for support. All that is required in the process of weaning is to separate the ewes from the lambs. The usual practice is to take the lambs away from the ewes, and, being taken to a strange pasture, they bleat loudly and incessantly; whereas if they are allowed to remain on the pasture they have been accustomed to for some time past, and the ewes taken away, the bleating will sooner cease. The ewes should be taken to a field lying far asunder from the one the lambs were left in, in order to be beyond the hearing of the bleatings of each other. The ewes should be put on bare, eaten, and not mown pasture, the latter being unfavourable to drying up the milk. The pasture of the lambs should be frequently changed after the bleating has ceased, say every ten days; and, where such is at hand, they thrive well on hilly pasture for some weeks at this time, the astringent quality of which giving an excellent tone to their system, and rendering them more hardy for the winter. Some farmers even hire rough hill pasture for their lambs; but where such cannot be had, they put them on the oldest good pasture, for a few weeks before the aftermath is ready to receive them.

3995. The ewes which were forsaken by their lambs after being clipped, should be daily observed by the shepherd, to ascertain whether the milk confined in the udder is troublesome to them; and for this purpose they should be caught occasionally, and the milk taken from them, until the

general weaning takes place. The ewes, when separated from their lambs, should be kept in a field of rather bare eaten pasture, until their milk be dried up. They must be milked by the hand, for a few times till the secretion ceases—once, 24 hours after the lambs are taken away—again, 36 hours thereafter—and the third time perhaps 2 days after that. Even beyond that time a few may feel distressed by milk, which the shepherd should relieve at intervals until the udders become dry. Milking them after the weaning of the lambs is essential to the safety of the ewes, and I fear that it is not so effectually performed as it should be until the udders become dry. The danger to be apprehended from its neglect is the plugging up of the teats with caseous matter, deposited therein by the milk which should have been drawn away; and which plugging, in the next lambing-season, will probably prevent the natural flow of the new milk; and the consequence will be, that inflammation will be set up in the udder, and the ewe either take puerperal fever, that is, *udder-clap* or *garret*, (2596,) and die, or her lambs be so restricted of milk as to be half starved.

3996. Ewes are milked in a very different manner from cows. A long narrow bught, *a a* fig. 338, formed of hurdles, fig. 40, on both sides, when the fence of the field is a hedge, and only on one side when it is a stone wall, as in the figure, is erected along the fence close to the gate of a field near the steading; and it should be no larger than to contain all the ewes in a crowded state. The ewes being driven into it head inwards, women proceed with the milking, which is done by placing a small handy, *c*, on its edge on the ground, and sitting down *behind* the ewe, as at *b*. The milk is stripped clean from the teats alternately, with the right hand into the handy, while the left hand presses the udder of the ewe towards the milker. The milker requires to be always on her guard, to remove the handy the instant she observes the ewe showing the least symptom of voiding either water or fœces; and a ewe is apt to void the former whenever her udder is touched for the first time from behind. The milk from every ewe is poured from the handy into the milking pail, *d*. Every ewe is turned out of the bught by the

shepherd, who waits for that purpose, hand again; and the milkers move up the as it is milked, to prevent its coming in bought as the ewes are turned out, to keep
Fig. 338.



THE MILKING OF EWES.

the un milked ones as close together as possible, in order to prevent them starting forward or aside in the act of milking.

3997. Time was when ewe-milking created a great stir in the farm-house in the making of ewe-milk cheeses; and so much anxiety did housewives evince for this process, that the ewes were milked until they were perfectly lean, to supply a sufficiency of this sort of milk. Better ideas now prevail, and farmers very properly will not allow the ewes to be milked oftener than is requisite to make them completely dry. It was misplaced economy to reduce the condition of the entire ewe-flock for the poor boast of making a few strong-tasted cheeses.

3998. One great means of warding off the attack of the fly on hogs is *doddering*, particularly in localities obnoxious to flies. This operation consists of clipping the wool from off the tail and between the hind-legs. Should hogs scour, which they are not unapt to do when put on foggage immediately after being weaned, and where there is no rough moory or hilly pasture to put them on for some weeks, the removal of the wool will prevent the discharge remaining about the animal, and, of course, deprive the fly of one object of attraction. The use of docking the tails of lambs is now made obvious, (2573.)

3999. Some breeders of Leicester sheep annually dispose of all their lambs, immediately after being weaned, except a few ewe-lambs to freshen the ewe-flock; and such breeders keep a larger flock of ewes. This difference of management does not arise from caprice, for it is found that some soils will maintain ewes in good keeping condition which will not put hogs in the condition they should be; and there are large breeding farms which cannot raise a sufficiency of turnips to maintain hogs in winter. Their are many markets convenient for the sale of lambs in summer, and it is no uncommon sight for from 50,000 to 70,000 lambs to be collected at a fair, such as at St Boswell's, Yetholm, Lockerby, West Linton, and Melrose.

4000. It is recommended by some breeders of lambs to dip them in a solution of arsenic and soft soap once or twice in the course of the summer, in order to get rid of the keds, fig. 308, which had escaped upon them from the ewes after they were clipped. Other liquors besides solution of arsenic, such as a decoction of tobacco and spirit of tar, answer the purpose, and should be preferred to that dangerous ingredient. The solution of arsenic will less affect the colour of the wool than the tobacco liquor; but that is of no consequence in Scotland, where the wool is never shorn from the lamb. The process of dipping is

the less necessary, when it is considered that the lambs, as hogs, will have to be completely bathed or smeared before being put on turnips in the commencement of winter.

4001. No sheep being bred on *carae* and *dairy* farms, and on farms in the neighbourhood of towns, the process of weaning is unknown on them; and on *pastoral* farms, as the lambs are a month later in being lambed upon them, the weaning is proportionally later than on low farms. Lambs ought on no account to be kept on the ewe beyond the first week of August, beyond which they will reduce the condition of the ewes to too low a degree to be regained before they are put to the tup in October.

4002. The milking of ewes was practised to a great extent on pastoral farms for the purpose of making cheese, but is now abandoned for the good and sufficient reason—that it is injurious to the condition and constitution of the ewes, to a much greater degree than the profit derived from the cheese afforded by their milk. “The wages paid for milking,” observes Mr Little, “are higher than any given for other out-door work; the quality of the wool is hurt, and the quantity reduced; and no part of the stock ever attain the strength and condition which those sheep do where the practice is laid aside; and of course the lambs must be fewer, leaner, and of less size, and the cast ewes neither the weight nor in the same condition. . . . About 12 or 13 weeks’ suckling is sufficiently long for hill-lambs, and will not be hurtful to the ewes, provided there is time to get them into condition before winter. At the weaning season sheep are easily hurt by being crowded into folds, and heated by running, owing to the imprudence of inexperienced servants being sent to catch them. By being new clipped and full of grass, they are then more easily hurt than at any other time of the year.”

4003. Mr Little is of opinion “that the lambs after being weaned ten or twelve days, might be allowed to go to the ewes, as by that time they would almost all find their mothers, and would not be able to bring them into milk, or do them any hurt, and at the same time they would enjoy the benefit of being led by them throughout the winter.”* Hill-lambs have a more acute instinct in recognising their mothers than Leicester ones, and in an open hirsels they might accompany their mothers with impunity, while, on a lowland farm, the ewes would be brought again into milk.

4004. *Lamb for the table.*—I think that every farmer who possesses sheep should supply his own table with lamb in summer. I am aware that breeders of the valuable kinds of sheep grudge to use their lambs at table, and no doubt the table would thus be supplied at considerable cost; but there are other modes of obtaining the end without making any sacrifice, such as purchasing a few Black-faced ewes and crossing

them with a Leicester tup. Such a cross will supply the requisite number of lambs of the finest quality for the table, and the ewes, before becoming old, could be fed and sold. There is no sort of meat so readily obtained and suitable for the table in summer, on account of its small joints, and being fit for use immediately when killed, as lamb. The jigot boiled, and the fore-quarter or loin roasted, and relished with a thin slice of toasted ham, makes an excellent dinner in a summer’s day; and who does not enjoy a cold roast rib and shoulder of lamb, with dressed salad, and cucumber, even in the hottest period of the dog-days, when the very sight of any other sort of meat would cloy the appetite? A sheep’s haggis has been lauded by poet and peasant, and though classed by the former amongst the “puddin’ race,” must be regarded as too substantial a dish for summer, but a lamb-haggis is a delicacy even in that season. A lamb’s head and lamb’s fry make sweet and savoury dishes. Thus every part of the lamb is eminently useful for the farmer’s table.

4005. *Pining.*—The rationale and cure of this fatal disease is thus attempted to be given by a writer:—“The disease called pining, seems to arise from an enervated and costive habit of the animal, which may be produced by a want of proper exercise, in conjunction with feeding in pastures of an astringent nature. The principal districts in which this disease is found to prevail, are the green pastures of the Cheviot mountains, the chain of hills running through the S.W. parts of Roxburghshire, the pastoral districts of Selkirk and Peebles shires, and some other districts of Scotland, as Galloway. Under the old practice of keeping the sheep in flocks, as they are termed *hirsels*, of weaning the lambs in the months of July or August, and afterwards of milking the ewes for 8 or 10 weeks, the pining was unknown in most of these districts; but under this mode of treatment, the sheep were frequently subject to diarrhoea—a disease diametrically opposed to pining. The farmers of those pastoral districts have generally improved upon the older methods of keeping their sheep. They find it to be more profitable to allow the whole flocks to pasture together indiscriminately and undisturbed. The lambs remain unweaned, until they wean themselves, which generally does not take place till the month of December. By this mode of management, the ewes and lambs are found to be of a higher comparative value than all the sum realised by the sale of cheese made from the milk of the ewes; be-ides, the ewes are not subject to the various accidents arising from so frequently collecting them together for the purpose of milking. But under this undisturbed state of management, in all cases where dry astringent pastures are produced, such as on the syenitic porphyry of the Cheviot range, the pining made its appearance. That such pasture promotes this disease, is further strengthened by the fact, that it is more common in dry than in wet seasons; and most so at that season of the year when, by the influence of the sun, the plants are less juicy; or early in

* Little *On the Mountain Sheep*, p. 63-5.

autumn, when the grasses which have pushed to seed become less succulent. This disease is not known on the whole of the greywacke range of the Lammermoor Hills, where heath prevails, occasionally interspersed with green pastures, and where the *hirsling* practice is pursued. Nor is it known to exist in general on green succulent pastures, or even heaths, growing on calcareous or sandstone grounds, where the nature of the food, and the exertion of the animal in procuring it, appears to counteract the progress of the disease, arising from the inactivity of the digestive function. If we suppose these to be the predisposing causes of this disease, the prevention or remedy will suggest itself, either under the head of food or treatment. Should it be deemed inexpedient to adopt the mode of keeping the flocks in hirsels, a change of place, and, consequently, of food, is necessary to accomplish this purpose. The salutary effects of a variety of food on the animal system are well known. When sheep affected with this disease are put upon a heath, it has frequently the desired effect; but when the animal is much overcome with the disease, its state of languidness may prevent it from taking such a quantity of food as to produce a reaction upon the animal functions. The most effectual cure, therefore, in all cases, is a change to a more rich and succulent pasture.*

4006. When lambs require to be bled, it is best done by opening the vein below the eye with a lancet, and the wound should afterwards be anointed with camphorated oil.

ON THE DRAFTING OF EWES AND GIMMERS.

4007. Immediately on the lambs being weaned, the drafting of ewes and gimmers, that is, separating those of them to be disposed of from those to be kept, may be conveniently done. Drafting only applies to a standing flock of ewes—a flying stock requiring no drafting, since, where all are disposed of, none obtain the preference of being kept.

4008. There are many marks of deterioration which determine the drafting of ewes. *Bareness of hair on the crown of the head*, which makes them obnoxious to the attacks of fly in summer—*deficiency in eye-sight*, which prevents them keeping with the flock, and choosing the best parts of pasture, and the best points of shelter—*ill-shaped teeth and jaws*, which disable them from masticating their food so well as they should—*want of teeth*, from old age, when, of course, they cannot crop sufficient food to support their lambs—*hollow*

neck, which indicates breeding too near akin—*hollow back*, which implies weakness in the vertebral column, thereby rendering them unfit to bear lambs to advantage—*flat ribs*, which confine the space for the fœtus within the abdominal region—a *drooping tail-head*, which affects the length of the hind-quarter, a space occupied by superior flesh—*bad feet*, which prevent travelling with ease along with the flock—*round and coarse bone*, which indicates coarseness of flesh—*thin or short coat of wool*, which lessens the clip and the profit from it—*diseased teat or udder*, which diminishes the supply of milk for the future progeny—*scarcity of milk*, by which lambs, not obtaining sufficient nourishment in the early period of their existence, are stunted in growth, and weakened in constitution—*carelessness of disposition*, which induces neglect of the lamb, particularly one of twins, which is in consequence ill nursed—*producing worthless lamb*, by which profits are much diminished—*missing being in lamb*, a failing which is apt to recur in every future year—*casting lamb*, a propensity likely to recur annually—*rotteness*, which is, of course, objectionable in every animal that produces young—*shortness of breath*, which prevents them seeking their food, and eating as much of it as they should—*tendency to scouring*, or *the opposite*, the former imposing weakness, the latter inducing inflammation—*delicacy of constitution*, which disables them from withstanding the ordinary changes of the weather—*diminutive stature*, or *inordinate size*, which spoils the uniformity of the flock. Such is a long list of faults incidental to ewes, which may all be observed in the same flock, and which every breeder is desirous to get rid of.

4009. It is not at all probable that any flock of ewes presents all these objectionable qualities in one season; but, notwithstanding this circumstance, it is not in the power of the breeder to draft every ewe having an objectionable property every year, since the farm supporting a determinate flock, the extent of the draft depends in a great measure upon the number of good substitutes which the gimmers may supply; and it is evident that no good object is attained by drafting a bad ewe,

* *Quarterly Journal of Agriculture*, vol. ii. p. 707.

and taking in its stead a bad gimmer. The number of gimmers fit to be transferred to the ewe flock, should therefore be, in the first instance, ascertained, and then a corresponding number of the worst ewes should be drafted.

4010. In *drafting gimmers*, many of the above faults may be observed in them, although those arising from lamb-bearing cannot possibly affect young sheep. The faults incidental to gimmers are, bareness of hair on the crown of the head, ill-shaped teeth and jaws, hollow neck, hollow back, flat rib, low tail-head, bad feet, round coarse bone, thin and short fleece, rottenness, shortness of breath, tendency to scouring or otherwise, delicacy of constitution, diminutiveness of stature, and inordinate size. These faults are numerous enough, but not likely to be all observed in the same year, and less likely in the same individual. Most of them may be got rid of by rejecting females which have more than one of them, and by employing tups free of them all. When the external form is improved, the constitution is also strengthened. Gimmers, when they become ewes of the first season, are likely to be deficient in milk, careless of their young, and produce small lamb; but these faults may disappear in the succeeding year; and should this not be the case, the ewe, though young, healthy, and fresh, should be drafted. Ample drafting alone, both of gimmers and ewes, can insure a sound, healthy, well-formed, young, and strong-constituted flock of ewes.

4011. The *flock-ewes* and *flock-gimmers* may be put together, or kept separate, as circumstances may determine. If tupped together, they may go together all the season; but if not, which is always the case on large farms where more than one tup is employed, they should be grazed separately, to save the trouble of separating them afterwards. Both should be kept on moderate pasture, to prevent attaining too great fatness before the tupping season, which commences the second week of October; but good fresh aftermath of grass, or, what is still better, rape, for about two or three weeks before the tups are put amongst them, will not only make

them fresh, but will cause the season to come on them more strongly and equally than without such assistance. Poppy-cake bruised and served in troughs, fig. 52, answers this purpose well.

4012. The *draft-ewes* and *draft-gimmers* should be put on the best grass the farm affords, immediately after being drafted, to fatten as soon as possible, as they are usually sold before the time arrives for putting lean sheep on turnips. The ewes which have missed lamb, called *tup-cild ewes*, having had no lamb to rear, will be fat in the early part of summer; and when kept to the end of autumn become very fat, not less than 30 lb. per quarter, if of the Leicester breed. The draft-gimmers, and the draft-ewes which have borne lamb, may reach, by the latter period, 20 lb. per quarter. The gimmers should fetch the highest price, the *tup-cild ewes* should also yield good mutton, but that of old ewes is always dry. Drafts are ready for sale in September. St Ninian's fair in Northumberland is held on the 28th September for the sale of draft-ewes, and I have seen as many as 70,000 in it, fat and lean.

4013. Ewes and gimmers on pastoral farms are drafted on the same principles and for the same reasons as those on low-land farms.

4014. I have mentioned the use of poppy-cake for ewes (4011.) As the oil of one species of poppy, *Papaver somniferum*, of which it yields from 36 to 53 per cent, is used as an article of food in France and Germany,* the cake left after the expression of the oil is no doubt derived from those countries. I am not aware of any chemical analysis having yet been made of this cake, but Professor Johnston gives the analysis, by Rülmg, of the ash of the commoncelandine, *Chelidonium majus*, probably a cultivated poppy got wild, which is this:—

Potash,	33.72
Chloride of potassium,	3.98
Lime,	27.33
Magnesia,	5.92
Phosphate of iron,	2.10
Phosphoric acid,	17.67
Sulphuric acid,	2.63
Silica,	1.65
	100.00

Percentage of ash, 6.85†

* Thomson's *Organic Chemistry—Vegetables*, p. 430.

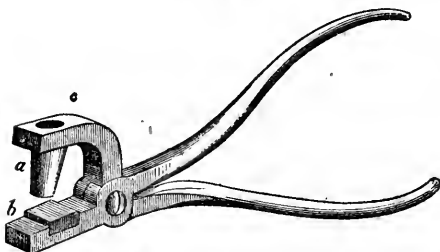
† Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 401.

ON THE MARKING OF SHEEP.

4015. When lambs cease to bleat for their mothers, they should be *marked* and *buisted*, not only to identify them with the flock of the farm on which they are bred, but as a record of the particular blood from which they are descended. The *markings* are confined to the *ears*, and consist of small pieces cut out of the fore or back margin, or a slit in the tip, with a sharp knife, or of holes punched through with punching-nippers, or of a combination of both sorts of marks. The female stock are always marked on the *near* ear, and the male on the *far* one. Thus, a single round hole is punched through the near ear of all the ewe-lambs, and a similar hole through the far ear of the wether lambs; and should any of the ewe-lambs be considered fit for breeding tups, they either receive an additional hole through the near ear, or a bit cut out from either margin of either ear, corresponding to a similar mark on their dams or sires, to distinguish their particular descent in blood. Twin ewe-lambs receive a hole through both ears. Tup-lambs receive no *ear* marks, their long tail serving the purpose till they are weaned, when they are at once transferred to the tup flock. Individual tups are so easily identified, and their descent so well known by the shepherd, that they require no marking; but where a large number of tups are bred, a distinguishing mark is always satisfactory.

4016. Fig. 339 are the *punching-nippers*, of which the inverted hollow cone *a*,

Fig. 339.



THE PUNCHING-NIPPERS.

having its small end sharpened to an edge, is employed to cut the hole—of any form, round, square, or triangular—out of the ears; and, to save the ears from being bruised in the punching, a pad of horn *b* is

inserted into the straight under-arm of the nippers, the pieces nipped out rising out of the orifice *c*. The figure at once shows how the instrument is used, being similar to the one used by shoemakers to punch holes into the lappets of shoes, through which the shoe-strings are passed. It costs 2s. 9d.

4017. Besides marks in the ears, letters are imprinted on the body with an instrument called a *buisting-iron*.

4018. *Buisting* consists simply of stamping a letter or letters, expressive of the initials of the name of the owner or of the farm, or of both, on different parts of the body. The buist or mark is effected by a simple instrument, fig. 340,

Fig. 340.



THE BUISTING- female, and the *far* side the IRON FOR SHEEP-male sheep. It costs 3s.

4019. The material of which the mark is made is tar, made viscid by a little pitch, both being boiled together in a metal pot.

4020. The sheep to be buisted are put into a convenient apartment of the steading, and handed out of a door, one by one, by one man, and kept steady by another holding the head and rump with his hands, and bulging out the side to be marked, the one opposite to himself, by pressure against his knee. The buisting-iron is then dipped by a third person lightly into the melted tar in the pot, to prevent dripping; and to make the mark vivid, the buist should be applied with a degree of pressure upon the entire surface at once, to compress the wool equally, and then withdrawn quickly. The wool must be quite dry, or the tar will not adhere to it.

All new clipped sheep are buisted in this manner, and though but a temporary mark, being in time obliterated, even on short wool, it answers the present purpose well. To my taste, the mark looks best on that point which is the roundest part of the rib, but others prefer it on the shoulder, the rump, or the loins. To save twice handling of the lambs, they should be marked and buisted at the same time, one person making the marks, another applying the buisting-iron.

4021. To save frequent catching, hill-lambs are marked in the ears with the peculiar mark of the farm, with the punching-nippers or knife, when they are castrated.

4022. Fig. 341 is an instrument for marking horned sheep and cattle. It is made wholly of iron, and on the upper face of the block is cut out as a die the capital letter to be used, such as S. The length of the instrument is about eighteen inches. It is heated in the fire, and the letter burns its form on the hair of the face, on the horns of the Blackfaced sheep, and on the horns of cattle. If heated high it may brand several sheep before it cools, but the most uniform brand is made when the iron is heated for every sheep; and, to carry on the work expeditiously, two brands at least should be used—one to be in use while the other is heating in a fire hard by, to and from which a person should carry the brands for the operator.



THE BRANDING-IRON FOR SHEEP AND CATTLE.

Branding is done on the same principle as buisting (4015.)

ON HAY-MAKING.

4023. It has often been alleged, that Scottish farmers have always shown little skill in the making of hay. Ready as I am to vindicate the general excellence of Scottish husbandry, I must own that the allegation is well-founded. Hay-making, as usually performed in Scotland, would induce one to believe that the period of conducting it had arrived unexpectedly, and the time spent upon it was thrown away.

4024. The practice commented on, delays the cutting down of the grass until it has passed its most succulent period—allows it to lie on the ground when cut till

it is bleached by the rain, scorched by the sun, or rotted by the growth of the aftermath penetrating through the swathes—puts the weather-beaten swathes together as fast as possible, into as large ricks as will keep the hay without heating—and permits the ricks to stand on the ground till the grass under them is destroyed. The grass thus treated is expected to make good hay!

4025. If it were desired to contrive a plan to make bad hay, the one just described seems to be the best suited for the purpose. The practice, however, is not unreasonable, for reasons, in explanation, though not in vindication, can be given, and they are these:—An economical desire exists amongst farmers to save as much rye-grass seed as will sow the land to be laid down to grass the next year, which comprehends the fourth, fifth, or sixth part of the farm, according to the rotation of the crops practised upon it. To attain this object, it is necessary to allow the rye-grass to nearly ripen its seed before it is cut down; and the easiest test to ascertain its ripeness, is, to sweep the hat smartly along the heads of the plants, and see whether it has caught any seeds. When rye-grass has attained this degree of maturity, the clover has passed its most succulent state, so that the crop is altogether too old to make good hay before it is cut down. To give time to the rye-grass seed to won, the swathes are allowed to lie for some days before being gathered into ricks. Hay-making arriving at the same time as the singling of turnips, it receives the less attention on that account.

4026. These reasons are sufficient to explain the object and the circumstances, but they offer no justification for pursuing a slovenly mode of making hay, since the object can be attained by a different and better procedure, which is this:—The quantity of rye-grass seed usually required is 1 bushel per imperial acre; and as a crop of mixed clover and rye-grass varies in yield from 25 to 40 bushels of rye-grass seed per acre, an extent of crop apportioned to yield the quantity wanted, would surely be a more rational proceeding than injuring a whole crop of hay for the sake of preserving a few bushels of rye-grass seed.

But after the crop has thus been injured, the best of the rye-grass seed is allowed to be shed upon the ground by the dilatory mode of making hay usually pursued. As for the interference of turnip-singling with hay-making, it is evident that if the grass were earlier cut for hay than it is, the hay might be secured past danger before the turnips were ready for singling.

4027. Hay is made both of sown and of natural meadow-grasses. The grasses sown in Scotland for hay consist of red clover, *Trifolium pratense*, and rye-grass, *Lolium perenne*; for although the white-clover, *Trifolium repens*, is sown along with these two seeds, (2633,) it forms no sensible part of the first year's crop, and therefore constitutes no portion of the hay. As hay is thus made from the first year's grass, it matters not whether the rye-grass is annual or perennial. The annual yields the heavier crop, but the perennial makes the finer quality of hay. The natural grasses constitute the hay of England and Ireland. The hay of the sown and of the natural grasses are certainly very different in appearance—the former is composed of the strong and stiff stems of the red clover and rye-grass, while the latter feels soft and woolly, and more odorous, on account of the sweet-scented vernal-grass, *Anthoxanthum odoratum*, always forming a component part. If both are equally well made, there is probably no material difference in their nutritive properties; but this fact has been established in Scotland, that the sown grasses are more nutritive for young stock, both sheep and cattle, than natural ones, and hence we may hold as true, that, made into hay, they will also be more nutritive for them. Natural grasses on the other hand are more nourishing to old stock than sown ones; and hence natural hay is best for cows and horses.

4028. I have heard farmers express the opinion that sown grasses require a different treatment to be made into hay than natural ones. If the object is to obtain rye-grass seed, the two processes should be different; but if it be to make the best hay, I cannot see why the treatment should be different. The nature of the plants employed is the same, and similar treatment should produce similar results in

them; and as the art of hay-making is merely to expel the water from the plants without injury to their texture, the only danger to be apprehended is excessive fermentation, which is easily excited in warm weather, and will proceed to a destructive extent, if not controlled; and when plants are allowed to lie on the ground until they are bleached, the art of making them into hay is virtually abandoned. Still hay-making is modified according as manual labour or mechanical assistance is employed.

4029. The hay crop is cut down either by hired labourers by the piece, or by the ploughmen of the farm. The grass is better and more expeditiously cut down by the piece, as contractors exert themselves more and work more hours than ploughmen, who have the charge of horses, can be expected to do. The usual cost of cutting grass for hay is 2s. 6d. or 3s. the imperial acre. I once let a small patch of 6 acres of clover, to be cut for hay, to a strong man, who undertook to do it for 2s. 6d. the acre, but, after the first half-day's work, he relinquished the agreement as being too low for him. And so it really proved; for on examination the clover was found so luxuriant that it was *kneed* down, that is, its lower part was lying upon the ground, while its upper part only seemingly formed the growing crop. He agreed to take 2s. 6d. a-day, the usual wages at cutting grass for hay, and after toiling hard for his money, the cutting cost me 5s. the acre.

4030. The implement used for cutting grass for hay is the same as that for cutting grass for forage—the common scythe, fig. 322, mounted on a bent or straight sned. He is the best scythe-man who keeps the keenest edge on his scythe, as he will not only do more work, but that more easily for himself. The edge of the blade is first formed by using one of two forms of scythe-stones, the round *a* and the square *b*, fig. 324; and then maintained by the use of the strickle, fig. 323. Of the two scythe-stones I prefer the round one, as the circumference of the circle affecting a smaller space of the scythe at a time in sharpening the edge, the stone is more easily drawn across the blade, and greater effect produced by the operator on any particular part of its edge. In sharpening

the scythe, it is placed on the left side of the mower, with the point of the blade resting on a small flat stone on the ground, the heel of the blade and sned being supported by the left hand. The scythe-stone, which is about 14 inches long, is grasped by one end in the right hand, which it fills, and is thus used:—The sharpening is produced by making sliding downward strokes along the stone on each side of the blade alternately. This mode of sharpening is based on the principle, that the scythe cuts after the manner of a fine saw, with the teeth set towards the point of the blade, and against the direction of its motion when cutting. The stone cannot conveniently be carried over the whole length of the blade at one sweep of the hand, so that only portions of it are sharpened at one time, and hence the sharpening begins at the heel, and proceeds downwards to the point. A few inches at the point are left untouched, and to reach these, the mower lifts up the blade, and holds it in the middle with the left hand, bringing it into a horizontal position, with the sned still resting on its end on the ground, and leaning against his rump to steady it while he completes the process by sharpening the point in the same manner as he did the blade, but with shorter strokes. Throughout this operation, the stone must always be held flat upon both sides of the blade, and if this be not attended to, the edge will either not be touched, or it will be too much rubbed and be rounded off: the consequence in either case will be, to render the scythe speedily unfit for cutting until it be re-ground upon the grindstone. It is this operation which tries the skill of the mower, in the same manner as the skill of the joiner is tested by his ability to keep a fine edge on his tools.

4031. Besides the stones and strickle, the mower should be provided with bits of thin leather to lay between the head of the blade and the sned, a few short broad-headed nails in case the grass-nail should come off, and a hammer to unloose and fasten the wedges used in the ring and handles.

4032. The instruments being prepared, the mowers are ready to commence the cutting. Two or three men form a gang or head of mowers, and two gangs of two

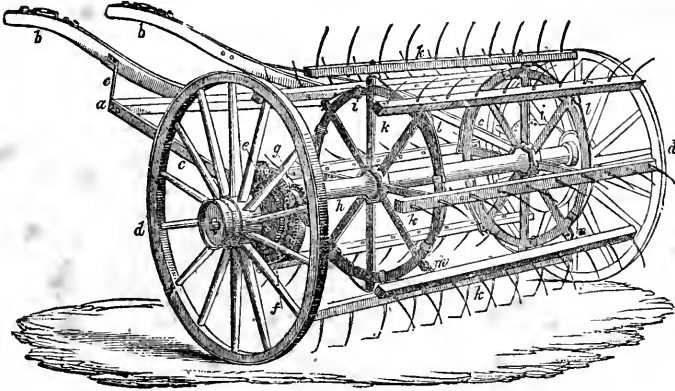
men each form a convenient division of mowers when the extent of ground to be mown is considerable. On a 500 acres farm under a five-course rotation, perhaps 20 acres of the 100 acres of new grass may be made into hay. It is fair work for a man to mow an acre of good grass daily, and when he goes over more ground, it is no good sign of the crop. On choosing the side of the field to make the beginning, the direction from which the clover leans, and, when it is scanty and the ryegrass thin and upright, the point from which the wind blows, which always determines the lean of a thin crop—should be chosen for the direction of the mowing, which should be conducted if possible across the ridges.

4033. Of the two methods of making hay—the English with the natural grasses, and the Scotch with the sown ones—I shall first describe the English method; and then it will be seen whether or not it cannot be used in Scotland with the sown grasses. It is a convenient beginning for hay-cutting to commence in the afternoon, as by the next forenoon the grass that has been cut will be tedded while the mowers are proceeding with their work for the day. The grass, however, should never be cut when rain falls, nor should any other operation connected with hay-making be then conducted.

4034. Next morning, if the grass be free of dew, and if not, in the forenoon after it is dry, the tedding machine is yoked to scatter the swathes of grass abroad to win, which the mowers had cut on the previous afternoon, as also that cut up to dinner-time of the present day, if the weather is likely to continue fair until evening. The English tedding-machine, which is represented in perspective in fig. 342, consists of a skeleton carriage, having a series of revolving rakes occupying the place of the body. The carriage is composed of the transverse bar *a*, with the horse-shafts *b b*. An iron stay-bar *c* on each side connects and supports the shafts. The ratchet-wheel *e*, attached to the nave of the carriage-wheel *d*, takes hold of the spur-wheel *f* by means of a pall, and carries it round when the machine advances, but slips hold on backing or turning. The spur-wheel *f* works into a pinion, which

is mounted on the end of the hollow shaft *h*; and though in the figure, for the sake of distinctness, the spur-wheel and pinion are exposed to view, they are in the machine closely boxed up to prevent entanglement from the hay falling between the wheel

Fig. 342.



THE ENGLISH HAY TEDDING-MACHINE.

and pinion. The two rake-wheels *i i* are of very light construction, and are fixed dead upon the shaft *h*, and armed with the eight rakes *k k*. The rakes are attached to the wheels by tumbling-joints *m m*, and are held to the work by the springs *l* only; by which arrangement, when any undue resistance is opposed to a rake, such as a stone or other obstruction, the rake falls back till the obstruction has been passed, when the springs immediately return it to its working position. Besides the capability of backing, without turning the rakes, there is provision for disengaging them when the machine is advancing. The machine is also furnished with the means of elevating and depressing the centre of the revolving rakes, and in consequence of bringing the rake-teeth nearer to, or farther from the ground.

4035. When in operation the machine is drawn by one horse, or sometimes two horses, and the result of the combination of the gearing is, that the revolving rake makes $4\frac{1}{2}$ revolutions for one of the carriage-wheel. The latter being 3 feet 10 inches diameter, will pass over 12 feet or thereby in one revolution, and the rakes being 4 feet 6 inches diameter over the extreme points of the teeth, will describe a circle of about 14 feet in circumference, and this revolving $4\frac{1}{2}$ times for one of the other, the points of the teeth will pass through 63 feet while the carriage has

moved over 12 feet, and as there are 8 rake-heads, there will be $8 \times 4 \cdot 5 = 36$ contacts with the substance which is to be lifted in a space of 12 feet, or one at every 4 inches. From this calculation it will be seen that the hay under the operation of this machine will undergo a process of teazling or tedding of the most perfect description; it will be separated and tossed about until no two stems of the plants will be left in contact, and by this exposure the drying process is effected in a period greatly shorter and more effectually than could be done by any number of hands. Thus, if suppose the horse to walk $2\frac{1}{2}$ miles per hour, and the machine to cover 6 feet in breadth, we have a surface of $1\frac{1}{2}$ acres nearly covered in an hour. There are some variations in the mode of constructing this hay-tedder, but not differing essentially from the one here figured, which has been drawn from those manufactured by Mr Slight of Edinburgh, where the price is £14.

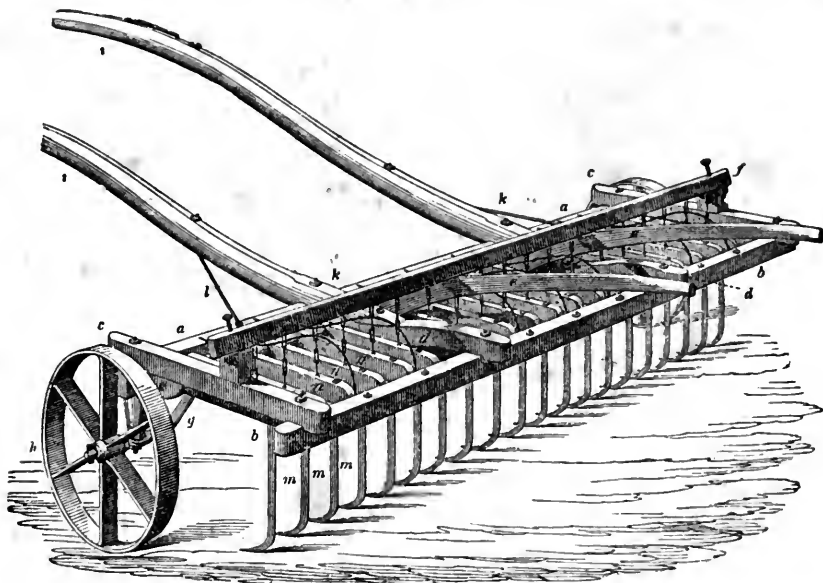
4036. Where there is no tedding-machine, the grass-swathes are tedded with the hand or with forks, fig. 110, care being taken to shake and separate the grass effectually.

4037. In the afternoon the tedded grass is raked together with the horse-rake. One of the most common forms is represented, in perspective, by fig. 343. The

body of the machine consists of a main beam, *a a*, and of a swing-bar, *b b*, of equal length, and these are bolted together upon

two side bars, *c c*, as also to the intermediate bars *d d*. The handles, *e e*, are jointed upon a bolt in *n* and are also

Fig. 343.



THE HAY HORSE-RAKE.

bolted to the lifting-bar *f*, which rest by noggs on the bars *c c*. The axles *g* are kneed. The wheels *h* are of light make in cast-iron, and the horse-shafts *i i*, worked to such a curvature that they shall be of the proper height for the horses' shoulders, when the body of the implement stands level, are bolted to the main beam and intermediate bars at *k*; and are likewise supported by the iron stays *l*. One horse-shaft is broken off for want of space. The machine is armed with 20 tines or teeth *m m*, &c., which are each fixed into a separate head *n*, while at the point they are bent forward and sharpened, but are adjusted so as not to run into the ground. Each of the rake-heads *n* is attached to the lifting-bar *f* by means of a short chain, whereby, when the handles *e* are lifted, the bar *f* and all the rake-tines are lifted from the ground by one operation, and when let down again, each tine is at liberty to rise and fall a small space, as the inequality of the ground or any obstruction may require. In the act of working, the machine advances till the tines have collected as much hay as can be contained in the bosom of the tines and heads, and,

when thus filled, the driver, by lifting the handles, causes the tines to be drawn upward through amongst the iron bent stripping-rods, which discharge the contents of the rake upon the ground; the handles are immediately let down to the working position, and the work proceeds as before. The usual price of this rake is from £3, 10s. to £3, 15s. Many varieties of this implement have been patented; but all the essential working parts of them are taken precisely from the earlier machines, similar to what is here described, and they are comparatively expensive, the price of the best being from £6 to £9.

4038. While the grass that was first cut is being raked with this machine across four ridges on to the fifth, the field-workers put the grass into small round-headed cocks, the size of which is regulated by the state of dryness the weather has permitted the grass to become. If the raker has taken a considerable start of the workers, which is the best plan, the latter may make as many ricks along one ridge as the raked grass will admit; but if the workers start but a short time after the

raker, they will have to follow him in his tracks across the ridges, and make up the ricks as there is grass raked for them. After the first cut grass has been raked, what was cut in the morning is raked. All the grass that had been teded must be put into small ricks before the workers cease from work that evening; and, to secure this result always, the quantity teded and mown should be regulated by the number of hands at command to put it into ricks in the course of an afternoon.

Fig. 344.

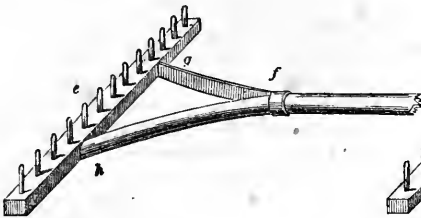
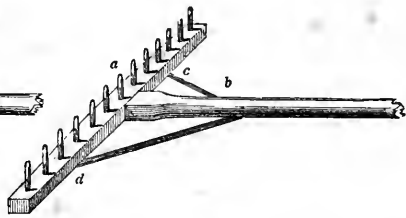


Fig. 345.



THE HAY HAND-RAKES.

12 or 13 wooden teeth, *a* or *e*, made of oak or ash, and about $3\frac{1}{2}$ inches long. The helve is usually made of ash, but, as lightness is an object, its thickness ought not to exceed $1\frac{1}{4}$ inch, dressed neatly smooth and round, except where the head enters. This part of it is either let into the middle of the head by a tenon, as in fig. 345, or split as in fig. 344, and enters it by two tenons. It is in this point of the construction that the variations have occurred, and it is evident that the single tenon alone, as in fig. 345, is defective and weak; hence the grounds for the variation, to afford some additional support to the simple tenon, and fig. 344 exhibits one mode of accomplishing the object; the shaft is split with a saw from the end backward to *f*, at which point it is prevented from splitting further by an iron ferule drawn tight upon it; the fork is then opened, the ends adapted to the respective mortises, and secured into the head of the rake. This is apparently a very simple mode of accomplishing the object, but it is not a perfect one. Were it possible to make the two parts *f g* and *f h* free of curvature, the object would be attained. A semicircular bow of bent ash wood has been often applied, passing through a hole at *b*, fig. 345, and entering the head at *c* and *d*, but this, by reason of

4039. Where there is no horse-rake, the grass must be raked together in the same manner with the hand-rake, and no more of it raked together than can be ricked by the workers at command. It is evident, however, that where the teding machine is employed, it is requisite to have a horse-rake to rake a space of ground corresponding to the extent of its operation. Figs. 344 and 345 represent the hand-rake in its most simple form and construction. It consists of a head *c d* or *g h*, made of hard wood, which is armed with

its curved figure, is also especially defective, besides weakening the helve. Equally so is a light iron bow of the same curvature, but, instead of passing *through* the helve, it is simply attached to it, and to the head with a nail at each of these points. This will be better in degree than the last, from the greater rigidity of the iron, but is not better in principle. The true and only mode of applying the bow is that exhibited in fig. 345, where the parts *b c* and *b d* are perfectly straight, and formed of very light iron rod; it need not exceed a quarter of an inch diameter, flattened at the two extremities, and at the point *b*, into a small flat palm, and fixed to the helve and the head by a screw-nail at each point. This part of the rake is called the stay or brace, and, in this form, is as perfect as the case will admit of.

4040. The mode of using a hand-rake is, on taking hold of the end of the shaft with one hand, with the palm uppermost, the head of the rake is projected as far on one side of the worker as the length of the shaft and the inclination of the body in that direction, with its weight on one foot, will admit. This distance will be found to be about $7\frac{1}{2}$ feet, or the half of a 15 feet ridge. The head is then drawn

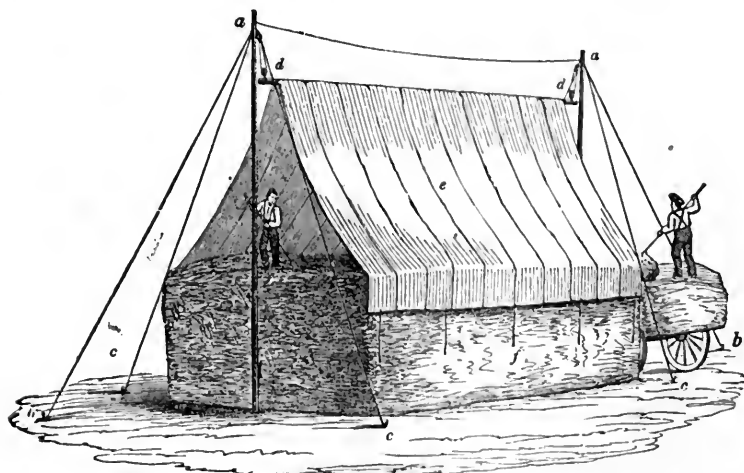
lightly towards the worker, and, as the grass accumulates under it, the other hand assists the raking, by placing its weight upon the shaft; and as the head thus approaches, with its load, nearer the worker, the second hand exerts its strength the more upon the shaft, while the first hand slips down the shaft as far as to ease the arm, when both hands seize the shaft firmly and drag the bundle of grass toward the feet of the worker, with a swing of the body on to the other foot, in a direction opposite to the body's former inclination. The rake may thus be used either on the right or left side of the worker. It is not every worker that uses the rake in this proper manner, many raking only a few feet, with a hold with both hands near the middle of the shaft, and then stopping, and, on stepping aside, raking the remainder of the requisite distance. The work is thus clumsily, and, as a necessary consequence, too slowly done. To make good work the rake cannot be too lightly handled—skimming it over, not pressing it upon the surface.

4041. Next morning, while the tedding machine is tedding the grass cut by the mowers in the previous afternoon, the field-workers first shake abroad, with the hand or with forks, the ricks that had been put up the previous afternoon, of the grass that was first cut, and then those of what was cut in the succeeding forenoon. If the sun

is at all bright and the air drying, the grass that was cut in the first afternoon will be ready to be stacked as hay in the afternoon of this the second day, while what was cut in the succeeding forenoon will have to be ricked again by that time. Besides this, what was tedded in the forenoon will have to be raked and ricked before evening. What should be aimed at is to stack as much as is cut every day, which may be accomplished in good weather; but, when rain comes, the hay must be kept in rick until fair weather arrives. The probable result will be, that with the grass mown by piece, the stacking will not keep pace with the mowing, more on account of the state of the weather, which may admit of mowing when the hay is not in a state to be stacked; but should the weather not promote the stacking, I think it would be better to cease mowing than to persevere in it in weather unfavourable to the making of hay, and, at all events, when the rain is heavy the mowing should certainly cease.

4042. The stacking of meadow hay should always be conducted under a rick-cloth, erected on purpose over the site of the stack. The rick-cloth is erected by setting up two light spars on the ground, on end, of such a length as their tops shall be about 2 or 3 feet higher than the top of the intended stack, such as *a a*, fig. 346, which are prevented falling backward by

Fig. 346.



THE MODE OF ERECTING A RICK-CLOTH OVER THE SITE OF A HAY-STACK WHEN IT IS BUILDING.

the top rope from *a* to *a*, and to one side or the other by guy ropes, two of which, *c c*, stand opposite to each other, on either side of the stack, and the third, *b b*, in the direction of its length; they being well secured to wooden stakes driven into the ground. A third spar, equal in its horizontal length to the distance between the poles, is hoisted up and down by block and tackle, *d d*, from each pole. The rick-cloth of canvass, *e*, is laid, at its middle, over the horizontal pole, and, if necessary, lashed thereto; and it forms a temporary and safe water-tight roof to the stack while it is building. The lower edges of the cloth are secured to the sides of the stack by the lines *f*, like reef-points. The canvass is hoisted up as the stack rises in height as much above it as to give room to the workers. The draught of air under the canvass thus hoisted is very considerable, and in consequence the hay dries whilst being spread upon the stack. The figure represents one man in the act of forking hay from the cart to the stack, and another adjusting the hay with a fork over the surface of the stack.

4043. Rick-cloths of all sizes are made by the manufacturers of canvass. In Scotland a rick-cloth of 36 feet in length and 30 feet in width,

Costs for canvass, . . .	£9 16 0
Blocks and hooks, . . .	0 14 0
Ropes of sizes, . . .	2 0 0
3 Norway spars, at 8s. each, . . .	1 4 0
Smith work, . . .	0 6 0
	£14 0 0

In England a rick-cloth of the same dimensions costs £15, and the mounting £4 more, £19 in all; but the canvass, being tweeked, is heavier, and more durable than the No. 6 canvass of the Scottish makers.

4044. An economical mode of carrying the hay to the stack is for a ploughman, with a cart and single horse, to load his cart with the hay in the field, forked to him by the person who builds the stack, and the ploughman, in his turn, forks the hay from the cart to the builder of the stack. A field-worker rakes the bottom of the small ricks forked in the field, and then carries the hay on the stack to the builder from the forker. In this way, three persons working the whole day, day

after day, will carry a large quantity of hay in the course of a week, and the quantities passing from hand to hand, being small at a time, dry effectually during the operation, while the stack augments slowly. But if this is found to be too slow a mode of proceeding with the stacking, another cart should be yoked, a man should fork constantly in the field, another as constantly build the stack, while one field-worker is raking the bottoms of the ricks in the field, another carries the hay upon the stack to the builder. And should this extended arrangement be found to be still too slow, another rick-cloth should be erected, and another stack be building under it at the same time.

4045. Hay stacks are generally built of a square oblong form, from 12 to 15 feet in width, and of such a length as can be conveniently covered by a rick-cloth, whatever its length may be. The number of stacks will thus be determined chiefly by the size of the rick-cloth. The body of the stack is carried to such a height as to be proportionable to its length, say 8 or 10 feet, on subsidence, the allowance for which should be at least one foot. The top of the stack is of a triangular form; and the rule for the height of the ridges is that adopted by builders of houses—one foot under the square. When the stack is 15 feet wide, the square would be $7\frac{1}{2}$ feet in height, one foot under which is $6\frac{1}{2}$ feet, which ought to be the height of the top of a stack of that breadth. The head is commenced by gradually taking in its breadth on each side to the ridging. One man at each end and a woman to carry hay to both will only find room at the finishing of the top of a hay-stack.

4046. The heads of hay-stacks are made in two forms, one with raised gables, the other with pavilion ends. The gables give a uniform mode of thatching, but are much affected by wind, and are, therefore, suited to a quiet situation. The pavilion suits any situation, and particularly a windy one. The gable form is shown in the hay-stack in the stack-yard, Plate I.

4047. Immediately after a stack of hay has been built, a heat will arise in it corresponding to the degree of fermentation

the hay is undergoing. It is impossible to prevent such a fermentation at all, unless the hay had been too long exposed to the weather before it was built; and a certain degree of fermentation improves the quality of the stack, by making the hay uniformly alike in it. While the fermentation is proceeding the stack subsides in bulk, and after the fermentation and subsidence have ceased, the stack should be thatched. But should fermentation continue as long as to affect the quality of the hay, means should be used to put a stop to it by shoring up the stack on both sides with stout posts, to allow the cool air to go into it.

4048. As a preparatory operation to the thatching, after the removal of the rick-cloth, the sides and ends of the stack are neatly trimmed from angle to angle, with a small increase of breadth to the eaves. This operation simply consists of pulling out the straggling ends of the hay, which give a rough appearance to the sides and ends, in order to render them smooth; and its use is twofold—to preserve the hay pulled out, which would otherwise be bleached useless by exposure to rain, and to prevent damp hanging about the stack.

4049. The heading or thatching is done with straw and straw-ropes. The straw is drawn in bundles, and the straw-ropes, made in time; and yet this is a matter not unfrequently neglected by farmers; and the hay-stack is allowed to stand unthatched until the corn harvest is finished, for want of straw, and even the hay is left in ricks in the field till just on the eve of harvest. Straw, in some instances, may be scarce, but, in such a case, rushes, and other tall grown wild plants, form an excellent substitute, both for thatch and ropes. Ferns and heath are good materials for thatch. The thatching should be carried on both sides of the stack simultaneously by two men, and begun at the same end. The men having mounted on the head of the stack, the bundles of straw are forked up to them one by one as they are needed, and each bundle is retained in its place on the roof, beside the thatcher, by leaning against a graip stuck into the roof. In a pavilion roof, the pavilion end is first thatched, and after it the sides are covered. The straw is first placed over the eaves, then handful after handful from the

eave to the top of the stack, each length of the straw being overlapped by the one immediately above it. When the thatcher feels a hollow or soft part with his feet in the head of the stack, he makes the part firm with some of the hay that was pulled from the stack, to save the wasting of thatch straw in filling up such hollows. The straw is thus laid from the eaves to the ridge of the stack to a breadth as far as the thatcher can reach at a time with his arms. When the men on both sides meet at the ridge, straw is laid along it, to cover the terminal ends of the thatch on the sloping roof, and to support the ropes which keep down the thatch. When this breadth, of perhaps 3 feet, or a little more, of the thatch is laid down, its surface is switched down smooth by the thatchers with a supple willow wand, and then a rope is thrown across the stack at its end, and another parallel to it at 18 inches apart, and made fast at both ends, in the mean time, to the sides of the stack. Other ropes, at right angles to the first, are fastened 18 inches apart to the hay at the end of the stack, when it has gable ends, and are placed across the thatching when the ends are pavilioned; and supposing the side of the roof to be 11 feet along the slope, 7 ropes running horizontally will be required to cover the length of the slope, leaving a space of 6 inches from the ridge for the place of the uppermost rope, and the rope at the eaves is put on afterwards. Each of the horizontal ropes are twisted once round every perpendicular rope they meet, so that the roping, when completed, has the appearance of a net with square meshes. As every subsequent breadth of thatch is put on, the roping is finished upon it, the advantage of which plan is, that the thatching is finished as it proceeds, and placed beyond danger from wind or rain, or derangement from roping afterwards. If the stack stands N. and S., the E. side should have a thicker thatching than the W., as being most liable to damp, and the thatching of both sides should be thicker towards that end of the stack which is farthest from the steading, as it will stand longest, and the process of thatching should terminate at the end which will be first broken upon, that is, nearest the steading, because the thatch will come away more freely when removed in the opposite direction from which it was put on. The hori-

zontal ropes at their termination are fastened into the gable, or across the pavilion, as the case may be. The eave is finished by laying a stout rope horizontally along the line where the roof was begun to be taken in, and twisting it round each perpendicular rope as it is met with, and then each perpendicular rope is broken off at such a length, as to fasten it firmly to the hay immediately under the eave; and then the projecting ends of the thatch over the eave are cut straight along the stack, to give the eave a neat finish. Another mode of roping the thatch, is to place one set of ropes in a sloping direction down the head of the stack, and another set sloping across these, the effect of which is lozenge-shaped, and looks well; but roping in this fashion requires the thatcher to place all the straw upon the roof before he guides the ropes across its ridge, in doing which he must stand upon the ridge and step backwards upon it—a plan which allows the wind the liberty to blow off the thatch before it is roped at all, and to injure the ridge by trampling, and the ropes cannot be twisted round each other without tramping on the thatch.

4050. Hay is sometimes built in *round* stacks, which are kept of a cylindrical form, 15 feet in diameter for 7 or 8 feet from the ground, and then terminated in a tapering conical top, and thatched. Such stacks contain from 300 to 500 stones of hay. This form of stack is convenient, when the hay-house contains the whole of it, but when it is bisected perpendicularly, the remaining half is apt to be blown over by the wind; or should the upper half be brought into the hay-house, the under part must be protected by a quantity of straw kept down by heavy articles, and such expedients are seldom done with sufficient care to keep out rain and resist wind. The oblong form is most convenient for use, and most safe: and a section of such a breadth as cut from top to bottom will just fill the hay-house (3086.)

4051. The above may be regarded as the English mode of making the natural grasses into hay, and that there is nothing in the process but what may be followed in Scotland with the same sort of grasses, has been

proved in Dumfriesshire by Mr Little, Carlesgill, and Mr Miller of Forest;* but let us see whether the sown grasses also of Scotland may not be made into hay by the same process. Suppose that the mowers start early every morning, there is nothing but rain to prevent what they have mown in the morning to be tedded, and exposed to the sun and wind before noon, and put into small cocks before evening; and notwithstanding the prejudice against the tedding-machine in Scotland, nothing else than rain can prevent it tedding the mown sown grasses, as well as the mown natural grasses, if the former are not purposely raised for seed instead of good hay—for the tedding-machine will most assuredly not allow the seeds to be retained in the plants. The object, however, being to make good hay, that machine, fig. 342, will certainly ted in a much superior manner every sort of mown grasses. But where no tedding machine is, the grass must be tedded with forks; and where there is not a sufficient number of forks, the shafts of the hand-rakes must be used, as such, in the inverted order. The tedding consists in tossing and separating the swathes into as minute a division as practicable, to expose the grass thoroughly to the air and sun.

4052. The tedded grass is gathered for the purpose of being put into small ricks in the following manner:—The grass is cleared from two ridges *cd* and *dk* on to the third *l*, fig. 347, on both sides of the third ridge, so that the cocks are raised on every fifth ridge. On clearing the two ridges, two workers are appointed to each ridge, having the ridge on which the cocks are to be made on the right hand, to suit right-handed workers. A man *a*, clears the grass with a fork from the farthest open furrow *p*, to the crown of the farthest ridge of the two, and a field-worker *b* follows him, and rakes the half of the ridge clean that he has just cleared. A second man, *c*, follows the field-worker *b* with a fork, and tosses the gathered grass from the crown of this to the open furrow of the nearest ridge of the two, and the second field-worker, *f*, follows him and rakes clean the half ridge he has cleared. On the second or nearest ridge, a third man, *g*, forks the accumulating

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 750 and 760.

swathe from the open furrow to the crown, his labour being greater than that of the men who have preceded him on the first

ridge, inasmuch as he has to move the entire grass they had brought from it along with what he finds upon the first half of

Fig. 347.



PUTTING THE SWATHES OF THE SOWN GRASSES INTO WINROWS.

the second ridge. A third field-worker, *h*, follows him with a rake, and cleans the half ridge from the furrow to the crown. And last of all, a fourth man, *i*, forks the grass from the crown of this over the open furrow of the third ridge; and a fourth field-worker, *k*, cleans this last half ridge with the rake; and of them all, the last man, *i*, is the hardest worked, the rakers throughout having the same degree and extent of labour. Thus, 8 labourers, consisting of 4 men with forks, and 4 women with rakes, are required to clear two ridges of grass, and the length of ridge cleared by them is just the breadth of 4 swathes of grass, which is more or less heavy according to the weight of the crop; and as mowers usually cut a breadth of 6 feet at each stroke of the scythe, and each breadth constitutes a swathe, the space cleared by the 8 workers is 24 feet by 30 feet, the breadth of two ridges, or 18 poles. In this way the band clears two ridges at a time, till they reach their end, the grass on the headridge being cleared

and mixed with that of the other ridges. They then wheel round at the end of the ridges to clear other two ridges *o*, beyond the third one, of their grass in precisely the same manner, on to the same ridge they had accumulated the grass of the former two ridges, and which centre ridge *mn* then contains the grass of 5 ridges. A difference in the arrangement of the workers takes place on the second set of ridges, the forker who took the lead in the former ridges, and had the lightest share of the work, now becomes the last forker, and takes the heaviest part of it, and he who had the heaviest then now takes the lead. To prevent confusion in changing the ridges, the same raker always follows the same forker, so that the band consists of 4 pairs, each consisting of a forker and raker. Women are quite as able to fork as to rake, but where their number is insufficient, men take the forks and women the rakes, as women use the rake better than men. When only a band of 4 workers can be spared to make hay, consisting of two

forkers and two rakers, they must go up one ridge and down the next, to clear the two ridges on each side of the third one, but a smaller band than four workers makes hay-making a dilatory process, and expensive in proportion to the number employed.

4053. The grass collected on the middle or third ridge, is called the *winrow*, and the first cocks made of it are small, and are called *grass-cocks*. They are put together either with the fork or the arms, with narrow bottoms, and high in proportion to their breadth, and not exceeding, perhaps, 2 feet in height. As there will not be room on the ridge, at this time, to put such small cocks in a row, they are put up anywhere, not to crowd upon each other, and to afford room for the rakes to clear the ground around them; and it is considered slovenly work in a hay-field to neglect clearing the ground with the rake which had been cleared of its grass by the fork. The raking at this time will not occupy more than one or two workers, and the rest are employed assisting the forkers to put up the cocks. The field is left for the night in this state.

4054. In Ireland the grass first mown is dexterously wrapped together with the hands and one foot into *lap-cocks*, which seem like bundles of green cloth turned upon their mouths, and which fend off much rain.

4055. Next morning the *grass-cocks* are shaken loosely out on the ridge, for exposure to sun and wind; and after this operation is finished, the grass which was cut in the afternoon of yesterday is tedded. In the afternoon the scattered *grass-cocks* are shaken up, after which the grass which was tedded in the forenoon is winrowed and put into *grass-cocks*, in the manner described above. Before the evening, the scattered *grass-cocks* are put into larger ones, named *hand-cocks*, which are best put together with forks by men. These have small bottoms, built tapering to a fine top about 6 feet in height, and placed in row along the crown of the ridge. The difficult part of making a *hand-cock* is the fine form of its top, which should also be as heavy as not easily to be blown off by the wind. The top is made in this manner:—Put small forkfuls of loose hay

above one another on the ground, and as much being put together in a heap as can be conveniently lifted at once, the fork is firmly transfixed into one side of the heap, which, on being lifted up, is quickly turned on the fork in a reversed position above your head, and planted with a stroke upon the top of the cock, when the fork is drawn gently from under it, and a slight tap and dress into form with the fork on the outside makes the rick neat and firm. The ridge is raked clean, as the *hand-cocks* are erected.

4056. The next morning, the third, the grass cut yesterday afternoon is tedded, and as much tedded in the afternoon of the grass cut early in the same morning, as can be put into *grass-cocks* before the evening. This is an easy day's work, and reserves strength for the greater labour of the next day, to which all the field-workers, labourers, and ploughmen, should be collected.

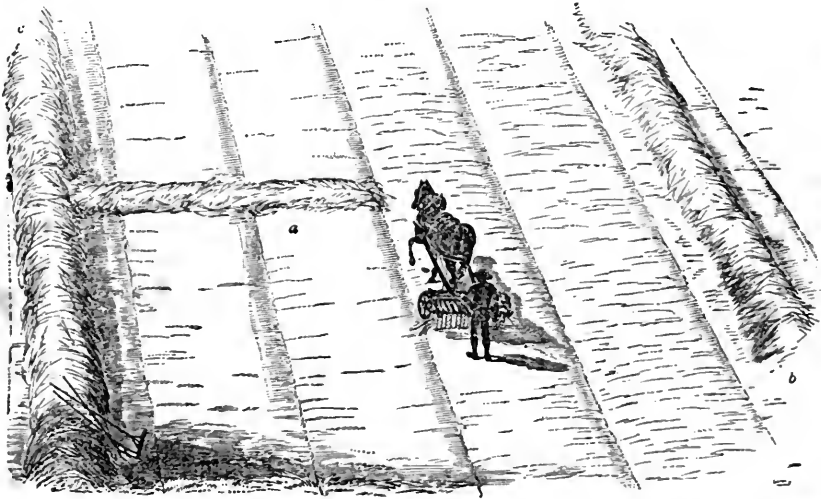
4057. Should the next morning prove rainy, let the whole field remain as it is, and let the mowers also cease their work. If fine, toss over first the *grass-cocks* to the sun and air, then tedd the small quantity of grass that was mown after the tedding of the previous afternoon, and, last of all, scatter the *hand-cocks* of last evening, which, by this time, will have subsided considerably. Doing all this will occupy, if not the whole, the greater part of the forenoon; but no more of those respective processes should be undertaken than the force in the field will put all the hay into cocks before the evening; and of those processes the tedding of the swathes may be dispensed with most safely. The first thing to be done in the afternoon is to put two or three of the *hand-cocks* into one. The hay will now feel light in the hand; and it is surprising how soon it wins after this stage, *when exposed fully to sun and air*. The usual practice is to keep hay a long time in the *hand-cock*, from a belief in its safety, whereas, having been put together in a clammy state, it will soon contract a musty smell; but if exposed to the air at this time, it will as soon become excellent hay. The reason assigned for allowing it to remain so long in the cocks, is want of time; but in truth it is to save the cost. The ricks or colls should be gently tapered to the top, without a projecting shoulder to catch the rain,

and fastened down with a hay-rope, twisted on the spot with the corner of a rake converted for the nonce into a rope-twister or throw-crook, and put across the top of the coll in the direction of the strongest wind to which the locality is subject, and fastened at both ends to the hay. After this operation, the scattered grass-cocks are put into hand-cocks, however small they may be; for, to allow scattered hay to remain on the ground all night to receive rain, or dew, is the readiest method of rendering it tasteless. The tedded grass is then winrowed and made into grass-cocks, which closes the labours of the day. In this manner I have led and assisted 16 field-workers, all women, to handle upwards of 2000 stones of 22 lb. each

of hay, within the limits of an ordinary day.

4058. Where a horse-rake is kept it is useful in saving a good deal of trouble, by entirely dispensing with the raking done by the field-workers in following the men with the forks. The men may then be dispensed with altogether, the women using the forks to toss the hay from the two ridges on to the third. After the grass has been winrowed, or while a part of the hay is in the act of being so, the horse-rake cleans the ground over the four ridges intervening between the ones containing the winrows. This is attempted to be shown in fig. 348, where the horse-rake is seen moving on the four intervening

Fig. 348.



THE HAY HORSE-RAKE CLEANING THE INTERVENING RIDGES BETWEEN THE WINROWS.

ridges between those on which the grass has been winrowed. The rows of grass, such as *a*, left by the rake, are collected by the workers when they put the winrows *b* and *c* into grass-cocks, and the ground occupied by them is cleaned with the hand-rake. Dispensing with the labour of men, and the raking imposed on the women, the horse-rake is a machine well calculated to economise the cost of hay-making. The method of working the rake is described in (4037.)

4059. As the entire produce of the field is stacked at one time in Scotland, the colls are placed in a state to stand the weather for a considerable time, putting

two or three into one, at that end of the field most convenient for carting them away to be stacked. The large ricks thus formed are named *tramped pikes*, because they are built and tramped, a man building, and his assistant, a field-worker, carrying the hay to him from the fork of the ploughman, who is employed with his horse and cart to carry the colls to the builder. Tramped pikes contain from 100 to 150 stones of hay each, and if the hay is to be disposed of, it is delivered to the purchaser from the pike, who stacks it for himself. The reason that hay is first piked, when it is all stacked at one time is, that unless it is in a state to keep in the stack, it is cou-

sidered safer from fermentation in the pike. The advantage of stacking hay under cover is, that it allows it to be brought from the field while in the coll, to be slowly stacked, and to be won, and the slow mode of stacking may be conducted by the ploughmen alone, while the field-workers are employed with the culture of the turnip; and there seems no better mode than this of avoiding the collision of work which constantly happens between hay-making and turnip culture. The rick-cloth is as available in the stacking of hay made from sown grasses as from natural ones, and, being so, there should be no hesitation in adopting it, and save the trouble and expense of piking, and the deterioration of the hay by bleaching upon the long exposed surface of the colls.

4060. A large oblong hay-stack is *built* in this manner:—A dry stance should be chosen, for a damp one will cause the destruction of several stones of hay at the bottom of the stack. It should be raised one foot above the ground with large stones inscribing the circumference of the space to be occupied by the stack, and the interior filled up with stone shivers or gravel beaten firmly down. A stance when made should be of considerable length, the breadth being 15 feet, and no harm accrues although the stack in any year does not occupy the entire length.

4061. Upon such a stance the stack is built by two men, who are supplied with armfuls of hay by a number of field-workers, whose duty is not merely to carry the hay, but to scatter it over the body of the stack, and tramp it under foot regularly from one end of it to the other. Each of the two men occupies his own side of the stack, and they shake and build up what is called a *dace* of the hay before them as high as their breast, from side to side, and from each end of the stack to its centre. After the centre is reached from each end, the women walk upon it, trampling it, holding by one another's hands in a row.

4062. The hay is forked at first from the ground by two or three men, and when the stack has attained an inconvenient height for the forkers, there are several modes by which the hay may be taken to a greater height; one of which is, placing

a short ladder against the stack, upon which a man stands on a step some way above the ground, with his back to the ladder, where he receives the forkfuls of hay from the forkers on the ground, and raises them above his head to the margin of the stack, where the women are ready to take them from him in their arms. Another mode is for men to carry back-loads up longer ladders, and empty them upon the stack. A third method is to erect a scaffolding of planks upon a couple of tresses of 6 feet or more in height, and to fork the hay off the scaffolding to the stack as it is forked to it from the ground. Of the three modes, the scaffolding affords the most secure footing to the men at an elevation from the ground, and in the end is the most expeditious; and in either mode four men will be fully employed in supplying hay to two builders. The hay is preferred to be forked off the ground instead of the cart, because it does not detain the horses in the yoke. The hay being thrown down upon the ground, the cart should be constructed to tilt up, like fig. 175; and it is thrown off a whole-bodied cart by sticking forks under the load along one side of the cart, and pushing upwards towards the other side, a person holding by the nearest wheel to prevent the cart upsetting. The load should be thrown over *from* the spot upon which the men stand to fork, because the hay then easily comes away with the fork, each stratum, as it was built on the cart, lying with its face towards the men; whereas, in a load thrown *towards* the forkers, the strata crop out against them, and every forkful must be pulled away by main force. In building the body of the stack, its breadth need not be increased, as the pressure of the top will cause the breadth at the eave to be sufficient to throw off the drop from the stem. After the body of the stack has attained 14 feet in height, the heading is commenced by gradually taking in the breadth on each side to the ridging, which is elevated a foot below the square, after subsidence, (4045,) and the ends are built perpendicular. The two builders and one woman will only find room at the finishing of the ridging of the stack. A few straw ropes are thrown over the ridging to prevent the wind blowing it off. The stack is left for several days to subside, which it will do to the extent of two feet.

4063. A height of 12 feet is enough for the body of the stack, after subsidence, and a width of 15 feet is a convenient one, the length being determined by the quantity of hay to be stacked. One of these dimensions *new built*, and 40 feet in length, will contain about 2000 imperial stones.

4064. Very probably heat may be indicated in some part of the stack a few days after it is built, by a leaning towards that part, heating causing consolidation of the hay. Props placed against the place will prevent the stack subsiding much farther, and a rake pushed in here and there into the stack, to the length of their shafts, will indicate whether the heating is proceeding upwards and to a dangerous extent. A gentle heating will do no harm, but rather good, by rendering the hay uniform in quality.

4065. Salt has been recommended to be used amongst artificial hay; and when hay is in a damp state, in consequence of bad weather, salt is an excellent remedy against mouldiness. It is sown by hand by the builders upon every *dace* as it is tramped down. The quantity used must be according to the state of the hay, but as that has never been correctly ascertained, it must be left to your own judgment. Perhaps a quarter of a bushel to the ton is a large enough allowance. Salted hay is much relished by all kinds of stock.

4066. The thatching of a stack of artificial hay is the same as that of one of natural grasses, (4049.)

4067. Hay is made on *carse* farms of the sown grasses, partly to supply food for the horses in spring, but chiefly to dispose of to the innkeepers in towns.

4068. On *pastoral* farms much less hay is made than should be. If more means were used to make it, the stock would withstand the severities of winter with less loss and in higher condition than they do. It is not possible to have much hay of the sown grasses in a hill country, but water-meadows might be formed in many situations where they are neglected. (1041.)

4069. The success of *dairy* farms depends much on the stock of hay they can command in the winter, and the larger the quantity of it from natural grasses is made any year, the greater success will the dairy have. A large

water meadow is as valuable a resource for good hay in winter on a dairy farm, as rich old pasturage in summer.

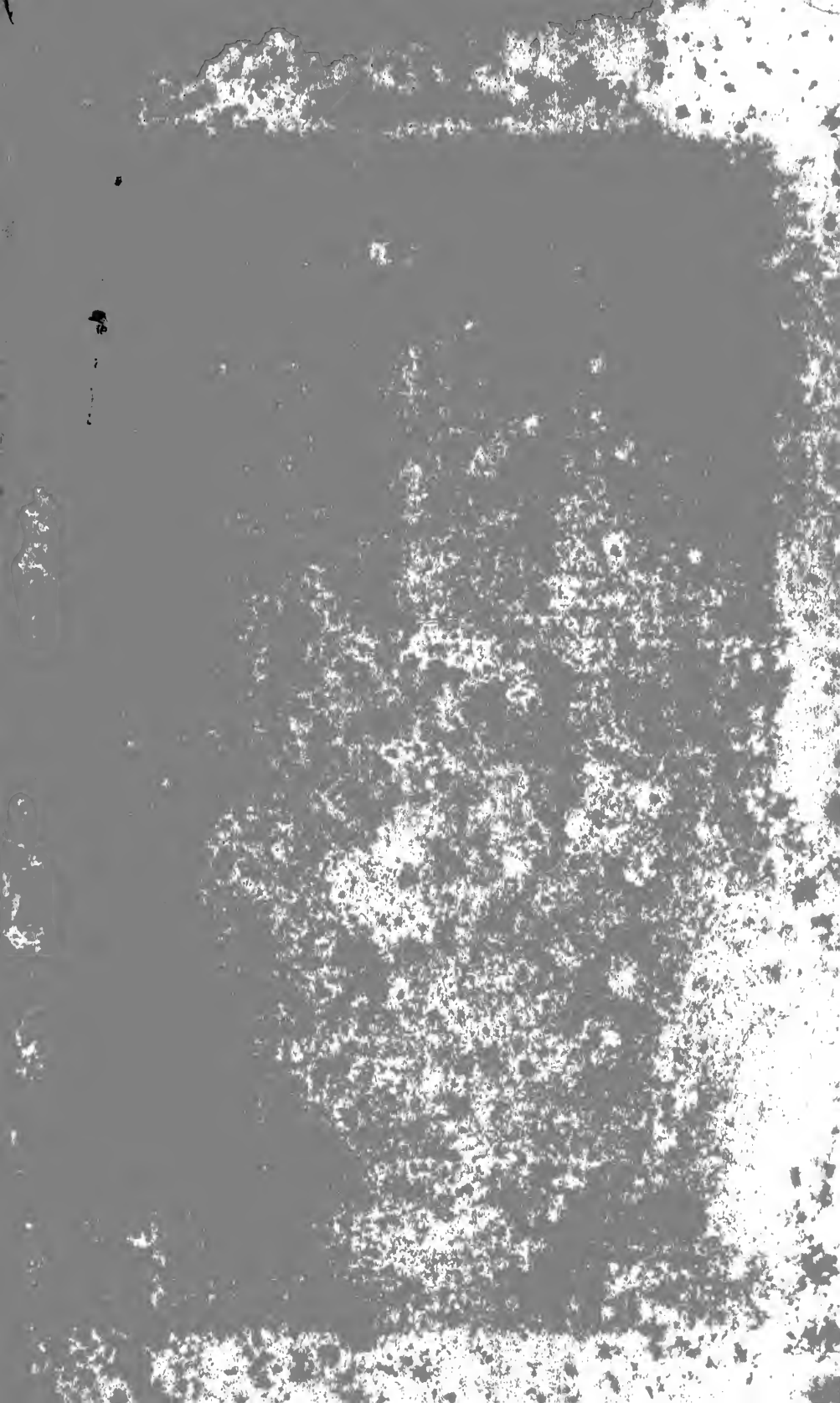
4070. In the *vicinity of large towns* it is more profitable to dispose of the grass in forage than to make it into hay. The average price may be stated from the tramp-rick at 8d. per stone of 22 lb. I have seen it as low as 4d. and as high as 1s. 4d. per stone; but when the price is high, the crop is deficient, and the quality bad. The heaviest crop of 300 stones at 8d. yields £10 the acre, but 220 stones is nearer the average produce; but grass lets for cutting £12 or £14 the acre in the neighbourhood of Edinburgh, without incurring any trouble to the farmer.

4071. As to farms of *mixed husbandry*, I have often thought it a loss to the farmer to make his grass into hay. The grass would pay better to be soiled, and the land would be retained in better heart. I am sure if half the labour were bestowed in winter, in cooking food for horses and cows as in making hay, even in the slovenly manner it is usually done, it would better fertilise the land.

4072. A crop of hay varies from 150 to 300 stones per acre, according to the season and the nature of the soil. On light gravelly soils the crop is of the former number, and its quality is generally fine; and on good clay it is usually the latter, and the plants large and strong, the clover predominating. For producing quantity and quality of hay combined, a deep mellow clay loam may be regarded as the best texture of soil. On thin clay, and on thin light soil resting on retentive clay, the clover is frequently thrown out by frost in spring, and the hay then consists chiefly of rye-grass, and on the same soils a similar effect is produced by severe drought in May, (3094 and 3095.) Grass usually loses two-thirds of its weight on being made into hay.

4073. Of the two methods of making hay, it is generally admitted that the English affords the best hay; and one of its chiefest recommendations is, the quickness with which all parts of the process is conducted. If we attend to the changes effected in the grasses after they are mown, we shall see that the quicker hay is made the better it will be. "When green grass or clover approaching to maturity is first cut down," observes Professor Johnston, "it contains a considerable proportion of starch, sugar, and gum, still unchanged into woody fibre, as it would mostly be were the plant allowed to become fully ripe." But even when succulent grass is "left to dry in the open air, the circulation proceeds to a certain extent, and, under the influence of light, woody fibre continues to be formed in the upper part of each stem, until it becomes completely dry." And "it may even be a matter of doubt whether the process of change does not often proceed after the hay has been carried off the field and stacked."* These facts tend to prove that the longer grass is

* *Transactions of the Highland and Agricultural Society* for October 1843, p. 59.





allowed to stand after the plant has attained its full stature, the less digestible and nutritious the hay becomes; and the longer the process of making the grass into hay is delayed, the more woody and less nutritious the hay will be. Every quick process of converting grass into hay is, therefore, better than any slow one.

4074. A very quick mode of making hay is practised in Saxony; and it is this:—The grass that has been cut down during the day is put into large cocks late in the afternoon. A strong fermentation soon ensues, which continues all night until the morning, when the work-people return to the field, by which time the cocks have contracted very much in bulk, and the steam rises briskly from them. They are then scattered upon the ground, and allowed to remain all day exposed to the sun and air, and by the afternoon the grass has become so dry and won into hay as to be fit to be stacked, for which purpose it is gathered from the ground and carried home. The new-mown grass of the day is put into large cocks in the evening, and treated the next day in a similar manner. This mode of hay-making might be followed in this country, provided we could trust our climate, as the Saxons do theirs; but here the next morning may prove rainy or even damp, and the fermented contents of the cocks would inevitably be rotted.

4075. The use of rick-cloths undoubtedly expedites the making of hay, and in the variable climate of Britain they ought to be much more generally used than they are; but where timber is cheap, a permanent shed might be erected in the stack-yard for containing the hay stack, under the cover of which it could require no thatching. In pastoral, as well as dairy farms, such an accommodation would be highly useful. Mr James Little, Carlesgill, Dumfriesshire, has given an estimate of what a shed for that purpose might cost, of 45 feet in length, 16 feet in width, and 12 feet in height, inside measure. These dimensions contain 7800 cubic feet, or 290 cubic yards, which, at 7 imperial stones the yard, is capable of containing 2030 stones imperial of hay, or 1292 stones of hay weight of 22 lb. to the stone. The shed consists of the following particulars, and their cost:—

14 posts 5 feet each, = 70 feet, at 1s. 3d. per foot,	
of larch trees 9 inches in diameter,	£4 7 6
90 feet of wall-plate, 9 inches wide, and 2½ inches	
thick, = 67½ cubic feet, at 3½d. per foot,	0 18 3½
363½ feet of 2½ inch planking for roof at 3½ per	
foot,	4 18 5½
1312 feet of ¾ inch boarding for covering the	
planking, at 1½d. per foot,	8 4 0
Nails,	1 0 0
Carpenters' labour for putting up the shed,	2 10 0
Levelling, sinking, and charring posts,	0 16 8
28 gallons coal-tar, at 4d. per gallon,	0 9 4
Putting ditto on the roof 2 days, at 2s. per day,	0 4 0
This is exclusive of carriage from the wood	
to the saw-mill, and thence to the stead-	
ing.	
	£23 8 3

If covered with "double slate," instead of boards, the cost would be, £25 10 10½
 If with "second" Lancashire slate, the cost would be, 31 15 10
 Exclusive of sinking the posts, the value of the coal-tar, and the cost of putting it on.

To save warping, the boarding is fastened with T-headed nails driven in the joinings, the cross-head of the nails overlapping the boards ½ inch, which allows for their expansion and contraction. Parallel to the joinings, and ½ inch from it, a groove of ¼ inch deep is cut along the upper surface of each plank to form a channel for rain.

Cost of thatching a 9-fathom rick with sprits and coarse grass is:—

Mowing thatch—drawing it in bundles—	
carting—and laying it on,	£0 4 11
Ropes making and putting on,	0 1 10
Material for thatch and ropes,	0 5 0
	£0 11 9*

The building of the stack is the same in every case, and these items of the cost of materials, when they are used, should, I think, be left out, as the manure afforded by them will repay their cost.

4076. The rule for ascertaining the number of stones of hay in oblong stacks, is simple:—To the height from the ground to the eaves add one-half of the height of the top above the eaves, for the mean height; then multiply the mean height by the breadth, and multiply their products by the length. Divide the gross product by 27, and the dividend will give the number of cubic yards in the stack, and that number of yards, multiplied by the number of stones of hay in a cubic yard, will give the weight of the stack in stones imperial. It is not easy to state the exact number of stones of hay in a cubic yard, as they must vary according to the compressed state of the hay in the stack, the age and size and part from which the hay is taken determining the degree of compression, which varies as much as from 5 to 9 stones; but perhaps 6 stones may be near the mark in a new stack, 7 stones in one which has stood for some months, and 8 stones in one a year or two old.

4077. The contents of a round stack with a conical top is more difficult to measure, but it may be ascertained in this way:—Take the height of the round part from the ground to the eaves, and add to it one-third of the perpendicular height of the conical top above the eaves, for the mean height of the stack. Take then the mean girth, which, if the stack is wider at the eaves than at the ground, is ascertained by taking the girth at the eaves, and also at the ground, and dividing their sum by two. Square the mean girth, and multiply the product by the decimal .0795, which will give the area of the base of the stack. Then multiply this area by the mean height, which will give the contents of the stack in cubic feet, divide the contents by 27, which will reduce them to cubic yards, and multiply these by the number of stones in the yard, according to either of the above supposi-

* Prize Essays of the Highland and Agricultural Society, vol. xiv. p. 758-60.

tions, and the capacity of the stack will be found in imperial stones.

4078. To know the contents of a conical rick or coil, take the girth at the ground in feet, find the area of the circle by the above method, and multiply the area by one-third of the height. The contents thus found in feet reduce to yards, and then multiply by the number of stones in a cubic yard. But the simplest plan, in all such cases, is to use any of the tables published for the purpose of saving tedious calculations, such as those of Ainslie or Strachan, the latter, however, are not sufficiently extended to comprehend stacks of the largest dimensions.

4079. When seed is desired to be obtained from rye-grass, it is better for the hay, as well as for the land, that four acres of the part of the crop where rye-grass most abounds should be allowed to remain a while until the seed is ready

for mowing, than that the whole crop should be injured by standing too long for the sake of the seed; and even the part which is to afford the seed should not be allowed to stand until the seed is ripe, because rye-grass seed is very easily shaken from its stalk. As it is mown, it should be tied in sheaves with thumb-made straw-ropes and set in stooks for a few days to win. After that the sheaves are built in hand-cocks, and, when these are ready, they are either taken to the stack-yard to be threshed by the threshing-machine, or are threshed on the ground. In using the threshing-machine for this purpose, it is troublesome to clean it, so I think the better plan is to thresh the crop in the field with the flail. This may be done, it is true, in the stack-yard, but it gets quit of the business most quickly when done in the field; and in any way, a favourable day as to weather should be chosen for the operation. Fig. 349 represents the particulars of the operation in a graphic

Fig. 349.



THE THRESHING OF RYE-GRASS SEED IN THE FIELD.

picture. An outside door answers well for the threshing-floor; and it is set upon two cushions of hay, which afford sufficient elasticity to the stroke of the flail. A field-gate is placed lengthways in continuation of the door, and the large barn-sheet (1740) is spread under the gate to receive the seed. The hand-cocks containing the sheaves, are brought to the threshing-floor by a horse *a*, which is yoked by the haims by means of a cart-ropes passing round the base of the cock. When the horse pulls, the cock slides upon the ground to its place of destination. A field-worker, *b*, rakes the rick stands clean, while another, *c*, loosens the sheaves, and pitches them upon the floor

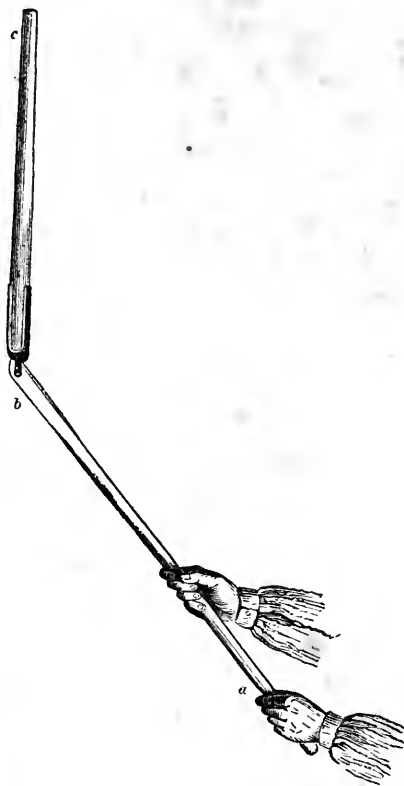
with a fork, with the seed end towards herself. Two men, *d* and *e*, one on each side of the floor, use the flail. Another field-worker, *f*, at the junction of the floor and field-gate, pulls the threshed hay with a long fork towards herself upon the field-gate, over which she shakes and tosses it, and another field-worker, *g*, removes it with a fork from the gate to the ground *h*. The threshers occasionally clear the door of seed with their flails upon the gate, through the spars of which it collects on the barn-sheet below. When the spars are filled up with seed, it is carried to one side at *l*, and riddled by a field-worker *k*, upon a sheet, preparatory to its being put into sacks *m*, to be carried to the corn-barn and win-

nowed. The threshed hay *h*, is forked by a man to a field-worker, *t*, upon the rick, which she is in the act of building of the form of the others *on*; *p* is a ladder to come down from the rick, and *r* is a spare rake; the basket at *s* indicates that a drink of beer is now acceptable to the workers. Thus, if one part of this busy band of workers supplies the other with sufficient materials, the work goes on pleasantly and without collision. The seed will more quickly part with its impurities in the winnowing, after it has lain to dry and win on the barn-floor for some days. After it is winnowed, it should be stored in the granary to win. When sufficiently dry, it should be winnowed in the granary, heaped-measured, and laid thicker together; and in spring, it should again be winnowed, and freed from the many fresh impurities which will have found their way into it during the winter, such as cats' and vermin's dung, cobwebs from the roof, and dust. Whatever proportion of the seed is not required for the use of the farm may be disposed of to a seed-merchant or farmer. A fair crop of ryegrass, even when not too much ripened, should yield about 26 bushels of seed to the imperial acre, when thus treated.

4080. The flail consists of two parts, the hand-staff or helve *a b*, fig. 350, and the supple or beater *b c*. The first is a light rod of ash about 5 feet in length, slightly increased in breadth at the lower extremity, where it is perforated for the passage of the thongs that bind the beater to it. The beater is a rod of from 20 to 36 inches in length, frequently also made of ash, though a more compact wood, such as thorn, is better adapted for it. If not properly applied, the ash beater will very soon separate into thin plates, which are portions of the concentric layers of the wood, and their separation arises from the beater falling upon the flat or convex side of these annular layers—or the reed of the wood, as commonly called. To prevent this disintegration of the wood, the beater should be constructed to fall upon the *edge* of the segmental portions of the *reed*, which is easily accomplished in its formation. The usual form of the beater is cylindrical, but frequently thickened a little towards the extreme end, the diameter being from $1\frac{1}{4}$ to $1\frac{1}{2}$ inch. For the most part it is attached to the hand-staff by a strap of leather, or more frequently of hide untanned; when mounted in this manner, the beater is formed with two projecting ears, standing at right angles to the side on which it is intended to fall, and about $1\frac{1}{2}$ inch from the end by which it is attached, serving the purpose of retaining the end of the beater within the strap. The strap is about 8 inches long and $1\frac{1}{2}$ inch broad; it is bent over the end of the beater, and the tails brought to embrace the sides of it beyond the ears. The strap being previously perforated with four holes in each tail, it is bound by a thong of leather laced through the holes and round the neck of the beater; the upper turn of the lacing thong catching the ears, prevents the strap from slipping off. The strap, thus applied, forms a loop standing about 1 inch beyond the end of the beater; and through that, and the perforation in

the end of the hand-staff, another and a stronger thong is passed several turns and secured, forming thus a kind of loose swing-joint that allows free action to the beater in its gyration round

Fig. 350.



THE HAND FLAIL.

the head of the thresher, and its descents upon the threshing-floor. Another mode of mounting the beater is by applying a strap of iron in place of leather, which is fixed to the wood by rivetting, leaving a loop as before, which must be nicely rounded and smooth, to prevent the too rapid chafing of the thong by which it is bound to the hand-staff, in the same manner as described above. The figure here described exhibits the iron strap.

4081. In constructing a flail, a very general practice prevails, which is to have the beater club-shaped, or thickest at the furthest extremity *c*, intended, no doubt, to give the better effect to the blows; but when we consider the effects arising from the manner of wielding the instrument, any additional weight at the extremity seems misapplied. The greatest amount of useful effect will be produced by the beater when every point in its length strikes the floor with an equal amount of momentum or force; but there will be a constant tendency to a larger

amount of momentum at the extremity *c* than at any other point, and a club-shaped beater will always augment this tendency—for the greater velocity of the extreme end, during the gyration of the instrument, multiplied by its greater weight, must give an undue preponderance of effect to that part of the beater, thereby lessening the general effect upon the work under performance. The opposite mode, which is also practised, to make the beater thinner towards the extremity, as exhibited in the figure, is more consonant to the laws of dynamics, and there can be no doubt that its practical effects will be equally favourable as compared with those of the club-shaped beater.

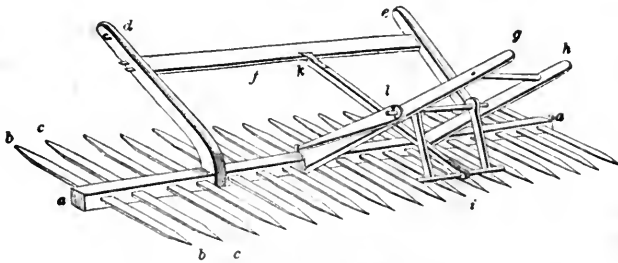
4082. The beater of the flail used in the United States of America revolves in swivel fashion around the end of the staff. In Holland and Belgium the beaters are short, thick, and heavy. In Switzerland flails are diminutive in size com-

pared to those I have referred to; and, in using them, four or five women range themselves in a circle on the threshing-floor upon their knees, and beat out the grain from the straw in short sharp strokes, following one another in rapid succession around the circle of threshers.

4083. The flail as a thresher out of grain is still very much in use in England; but a desire for threshing-machines is now, without doubt, strongly evinced in several counties; and ere long flails will there, as in Scotland already, only be seen in the possession of small farmers, who have not the means of procuring threshing-machines, or have no accommodation for them in their steadings.

4084. A peculiar form of hay-rake has been introduced into this country from America. It is represented in perspective in fig. 351, and lying in the working position. It consists of a

Fig. 351.



THE AMERICAN HAY-RAKE.

head *a a*, perforated with 18 transverse teeth *b b*, *c c*, &c., which are firmly fixed. These teeth are slightly tapering to each end, where they are rounded off to a blunt point, but chiefly upon that side which is to lie next the ground. It is drawn by a horse yoked to the draught-frame *d e*, at whose butts the head *a a* is dressed into a cylindrical journal, and each bar, *d* and *e*, is secured to it by a strap of iron passing round each, and leaving it freedom to traverse upon the journal. The handle-frame by which the implement is guided has the two bars *g* and *h* attached to the head *a a*, in the same manner as described for *d e*. Upon the lower stretcher of *g h* is appended the light movable frame *i*, jointed to swing freely on the stretcher. The bar *i* of this frame is put in connexion with the draught-frame *f*, by means of the connecting-rod *k l*, which is jointed movable at both ends on round journals, and strapped as before. The stretcher on which the frame *i* is appended, is prolonged at each end to receive the catch-bars *l*, on the outside of the frame *g h*, one of which bars is seen at *l*, jointed on the prolonged stretcher, and serving an essential purpose in the management of the implement.

4085. In the working of this rake, it lies nearly flat to the ground; and when the draught-frame is at its proper height, the connecting-rod *k l* keeps the hanging frame just within the extremity of the teeth that are then behind, and

nearly bearing upon them. In this position also, the point of the catch-bars *l* is quite free of the studs of the head, and, by pressing down the handle-frame, the pendant *i* will come down upon and depress the teeth that are looking backward, raising at the same time those in front, such as for the purpose of passing over any obstruction. When, on the contrary, it is wished to depress the front teeth, the handle-frame is raised till the points of the catch-bars press against their studs, which will depress the front teeth; and by continuing to elevate the handle-frame, the connecting-rod, from change of position in the bars *i k*, *l*, and *l f*, will push the pendant *i* beyond the extremity of the teeth behind, when the front teeth taking the ground, and nothing to resist the rising of those behind, the rake will immediately tilt over, the fore and hind teeth changing places; but, in other respects, everything will be the same as before. The effects of the motion and tilting, it is evident, will be, that in the progressive state the rake collects the hay upon it chiefly in the front part; and when the attendant sees that the rake is filled, he raises the handles and tilts the rake as above described, leaving the collected mass at the spot where the tilt occurs.

4086. A slight consideration of this implement will show the effectual and convenient manner in which its work is performed; but for progressive motion, it is by no means so well adapted as

for collecting and depositing the products. The heavy head *a* is drawn forward in the worst possible position, or what is called broad-side on; but this defect could be removed by simply applying a pair of low light wheels to the ends of the head. Perhaps it may be owing to this defect that the American hay-rake has of late years not been in such high repute as formerly.

4087. The hand hay-rake used in the United States of America seems a well-made implement. Its head is thicker and shorter than in fig. 347 and 348. The teeth are 4 inches clear of the head, and are turned and fitted into their places by machinery, besides being wedged and pinned. The shaft is curved for the last foot of its length, and is reduced in size before it reaches the head. It is furnished with two or three bows which pass through it and enter the head; and they are of use in enabling the raker to gather up a large quantity of hay at a single stroke. Every part being turned to fit exactly, these rakes are not only light, but are said to be remarkably strong and durable, seldom if ever breaking at the head or where the bows are inserted.

4088. A curious mode of preserving grass for forage, instead of making it into hay, has been tried in Germany, in East Prussia, and it is this:—Pits are dug in the earth 10 or 12 feet square, and as many deep. They are puddled with clay, and lined with wood or brick. Into these pits 4 or 5 cwt. of grass, as it is cut, are put in a layer at a time, sprinkled with salt, at the rate of 1 lb. to 1 cwt.; and if the grass is dry, that is, free of rain or dew, two or three quarts of water are sprinkled over the layer. Each layer is trodden down by 5 or 6 men, and rammed firm, especially round the edges, with wooden rammers, the object of which is the exclusion of air. A little straw is then scattered over the layer, to mark its dimensions afterwards. Layer is placed above layer until the pit is filled to the top, when the topmost layer is well salted, and the pit covered with boards or a well-fitted lid, upon which is put a covering of earth of 1½ foot in thickness. Such a pit will contain 5 layers of grass, and should be filled in 2 days. The grass soon ferments, and in about 6 days subsides to half its original bulk. The lid is examined every day, and every crack in the earth filled up, to exclude the air, which, if allowed to enter, would promote the putrefactive fermentation in the grass. When the first fermentation has ceased, the lid is taken off, and fresh grass put in, trodden down, and salted as before. The pit will now contain about 10 tons of grass, equal to 2 or 3 tons of hay. The pits should remain shut for 6 weeks before being used, and then are used in succession. The grass thus treated has the appearance of having been boiled, and its sharp acid taste is very agreeable to cattle; and 20 lb. a-day with chopped straw will keep a cow in good condition all winter, and 28 lb. will cause a cow to give a rich and well-tasted milk.*

ON THE SUMMER CULTURE OF WHEAT.

4089. The wheat crop in summer is in two states, when spring wheat is sown after turnips, (2302,) and when no spring wheat is sown the autumn wheat only exists which was sown after bare fallow, beans, and potatoes.

4090. The state of the autumn-sown wheat in summer depends entirely on the sort of weather in winter and spring, and on the nature and condition of the soil upon which it was sown. Mild weather will cause it to grow luxuriantly; and if it continue so for some time in winter, the plants will probably become so luxuriant as to lie down in spring, and become blanched and rotted at the roots, (2660.) In the earlier part of the winter, as long as the ground is dry, sheep may safely be put upon the land, to eat down the wheat to a considerable degree. Should the weather be wet, and the land soft, the sheep will poach the ground; but, even under such a risk, they will do much good to the crop when allowed, for a limited time, to eat off the tops of the plants twice a-day, when hungry, and to make their lair on an adjoining grass field. But the winter luxuriance is not unfrequently checked, and even the plants destroyed, by the severe frosts at night, and the bright sunshine during the day in March, (2660.)

4091. Besides over-luxuriance, early sown wheat is apt to be affected by slugs, *Limax cinereus*, in damp weather in autumn. Mr Wentworth of Harlow gives a recipe for destroying the slugs. "Provide, fresh from the kiln, as much lime as will allow five bushels to the acre. Slake it two days before sowing; choose a calm and mild morning; commence sowing early enough to finish before daylight; and one man can sow an acre an hour, sowing two yards at a cast." Turnip-leaves have been recommended to be laid upon wheat, to induce the slugs to take shelter under them, which they readily do, and they are then collected from the leaves and destroyed. Of these two modes of destruction, I should conceive the quicklime to be the more efficacious, on a large scale, in moist weather.

* *Verhandlung des Baltischen Vereins für Förderung des Landwirthschaft.* Greisswald, 1842, p. 33.

4092. Should the winter luxuriance continue on the wheat until spring, sheep will not then crop it in a uniform or sufficient degree. If the luxuriance has only commenced in spring, sheep will restrain it then as well as in winter. The winter luxuriance can only be restrained in spring by mechanical means, such as the field-workers cutting off the tops with the common reaping-hook; and this operation may be safely performed until the plant puts forth the shoot-blade, perhaps as late as the end of April. The scythe, fig. 322, may also be employed to mow off the luxuriant leaves, which should be done at the place they bend over. Before commencing the cutting either with the hook or the scythe, one of the most forward plants should be cut open, and the position and length of the ear ascertained, which will probably not exceed half an inch in length. The portion of the leaves cut off should be allowed to lie upon the ground, as the injury done by their removal will be greater than they can do to the growing crop, and they will soon wither.

4093. The advantages of cropping the wheat plant when over-luxuriant, are, that the rain no longer hangs upon it, and the air and light have power to act upon the stem so as to strengthen and increase the woody fibre in it, that the latter may support the former in an upright position.

4094. Wheat sown in spring never grows too luxuriantly in summer, and requires no expedient to check its growth.

4095. Of the classes of soils which produce over-luxuriance, dry deep clay loam is most apt in a mild autumn and winter; and thin clay land, upon a retentive wet subsoil, is the most sure to destroy luxuriant wheat in March (2660.) The crop may seem very promising in early spring, and yet by the end of March it may not only be thin but scanty of plants, and it is then too late for them to tiller fully. Such is the explanation of what may seem surprising in many cases as to the cause of the failure of what was at one time a good crop of wheat.

4096. The weeding of the cereal crops in summer is an indispensable operation for their welfare. It may be conducted solely

with manual implements, or with both manual and horse implements. Among broadcast grain the weeding must be per-

formed entirely with manual implements, and the most effective one for the purpose is the simple *weed-hook*, fig. 352. It consists of an acute hook of iron, flattened, of the form at *a*, with the two inner edges as far set asunder as to embrace the stem of succulent herbaceous plants, and made as sharp as easily to cut through them. The cutting hook is attached to a neck of iron, which is forged at the other extremity into the form of a socket, to take in the end of a light wooden handle about four feet in length, to which it is fastened by means of a nail or screw. The neck is bent in the form that, when the under surface of the hook rests upon the ground, the handle shall be so inclined as to suit the hand of the worker. The weed-hook is used with one hand, the field-worker walking upright, and holding it by the handle before

THE WEED-HOOK.

her in an inclined position towards the ground. The cost of this implement is 4d. for the hook, and 2d. for the handle. I have seen a weed-hook with its outer edge also sharpened, for cutting weeds with a push forwards; but such a one cannot be used amongst standing corn, since its sharp outer edge would inevitably cut their stems.

4097. The ordinary way for field-workers to arrange themselves, when weeding broadcast corn, is for two to occupy the breadth of a single ridge, each taking the charge equivalent to a half ridge from the open furrow to the crown. On weeding amongst corn, the point of the weed-hook is insinuated between the stems of corn towards the weed to be cut, and on its stem being taken into the cleft of the hook, it is severed by a slanting cut upwards, by an easy draw of the hand towards the worker. The weeds, thus cut over are left on the ground to decay.

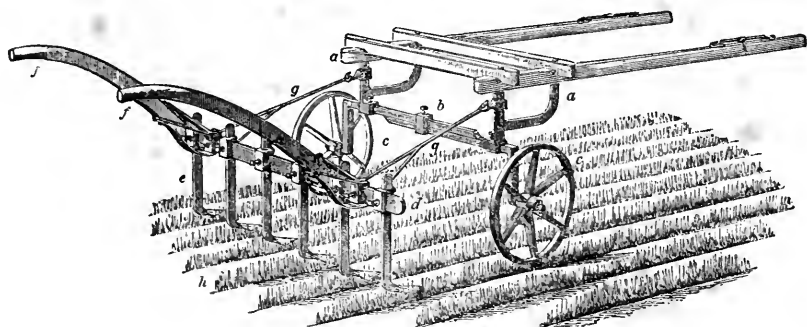
4098. The principal weed which infests wheat is the corn-cockle or popple, *Agro-*

stemma pithago. Having a woody stem, it is not cut with the weed-hook, but pulled by hand; and it is easily distinguished by its bell-shaped upright pink flowers. Its seed is black, rough, and round, and is much objected to in samples of wheat by bakers and corn-dealers, though, the kernel being white, its flour is not distinguishable from wheat-flour, and is reported to be injurious to it. In dry ground is found the long prickly-headed poppy, *Papaver argemone*; and in strong ground the hairy tare, *Ercum hirsutum*, though a low insignificant plant, yields a hard heavy seed, difficult to winnow from wheat. The blue-bottle, *Centaurea cyanus*; smooth rye-brome grass, *Bromus secalinus*; the corn and common sow-thistles, *Sonchus arvensis* and *S. oleraceus*; the corn groom-well, *Lithospermum arvense*, the seeds of which contain a large proportion of siliceous matter; the bearded darnel, *Lolium temulentum*, which is now rare, are all found among wheat. The cleavers, or sticking grass, *Galium aparine*; and the common hemp-nettle, *Galeopsis tetrahit*, and *G. versicolor*, large-flowered hemp-nettle, are also found among wheat. Any of the natural grasses do no harm amongst corn; their seeds, being light, are easily blown away in the process of winnowing, or even of threshing; but the plants formerly named all bear seeds as heavy as cannot be easily got quit of in threshing and winnowing, and are therefore troublesome in the barn, and injurious to the sample. The common reed, *Arundo phragmites*, is not uncommon in corn-fields on carse-land, and, when not too plentiful, is not disliked, as it serves to keep the corn open in the stook and in the stack.

4099. Wheat sown in rows is weeded with the hand-hoe, fig. 266, and also with horse-hoes. The hand-hoe is used by field-workers, who each take a drill and hoe the ground between the rows, as also between the plants in the rows, which is not so easily done as when the rows are dibbled, fig. 290, and must be done by the hand. In weeding rowed corn it is necessary for the field-workers each to occupy a row; and to prevent their jostling one another, the one in the centre of the band takes the lead in an advanced position, while the others range themselves on each side in echelon. Where the extent of drilled crops is considerable, hand-hoers are unable to clear the ground of weeds before the crops advance to a state in which it is improper to go amongst them. Hence the need of assistance from the more expeditious horse-hoe.

4100. There are many forms of horse-hoes for cleaning the ground between the rows of corn, and perhaps not one displays so much ingenuity of construction as that of Messrs Garrett & Sons, Leiston Works, Suffolk; but as its construction necessarily enhances its price, I have seen no cheap one please me so much as the steerage horse-hoe contrived by Mr William Smith, Northampton. It is shown in perspective in fig. 353, where *a a* is the framing, which also constitutes the horse shafts, supported on iron brackets, which in their turn are supported on an iron axle, *b*, as high as to permit the crop hood to pass under it. The axle, bent down at both ends, works in the wheels. *c c*. These form the carriage portion of the machine. The hoe consists of a bar *d*,

Fig. 353.

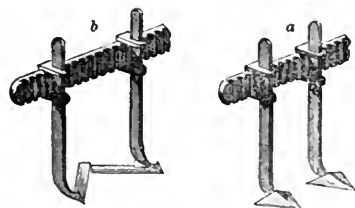


SMITH'S STEERAGE HORSE-HOE.

which bears the shanks *e*, of six triangular duck-footed hoes, or shares, made to embrace as many rows of corn, at the ordinary breadth of 7 inches asunder. The handles, *f f*, by which the driver guides the hoes along the centres of the rows, are attached to the bar *d*. The carriage and hoe are connected by means of the rods *g g*, which, at one end, are attached to the handles *f*, and at the other linked on by eyes to hooks in the hind part of the brackets, which support the framing or shafts *a a*. The rods *g* are strengthened by others, passing under the bar *d*, and welded at both ends to the under part of *g*. When the rows are placed wider than 7 inches, the axle is expanded to the requisite width by being slipped outwards through the collar, and fixed at any given width by the pinching screw at *b*.

4101. Fig. 354 represents two differ-

Fig. 354.



LONG AND SHORT SHARES FOR THE HORSE-HOE.

ent sorts of shares used in this hoe, one *a*, being the ordinary one for narrow rows of 7 inches; the other, *b*, to answer the broadest width of 18 inches. The latter consists of a long rectangular feather attached to each shank placed in a diagonal direction across and meeting in the centre of the drill. The inclination of their edges allows the shares to clear themselves of the soil while they are cutting the weeds under the surface. Having the bar *d* as long as the width to which the axle may be expanded, the requisite shares might then be affixed to it, required to hoe the number of rows determined on—and thus the hoes may be increased in number from 6 to 12, and the breadth hoed from $3\frac{1}{2}$ to 7 feet; but from 4 to 5 feet in width is the best one for doing the work quickest and most effectually. To obtain that distance, 8 hoes at 7 inches wide give 4 feet 8 inches; 6 hoes at 9 inches wide give 4 feet 6 inches; and 6 hoes set

at three doubles as *b*, at 18 inches wide give 4 feet 6 inches. The prices of this horse-hoe, at these respective widths, are—with 6 hoes, £4; 8 hoes, £4, 10s.; and 12 hoes, £5, 10s.

4102. In using this hoe, the horse is put into the shafts *a*, fig. 353. The driver holds on by the handles *f f*, and steers the hoes along the centre of the rows *h*, which he is enabled to do by the movement of the rods *g* upon the hooks attached to the brackets at *a*. Should the horse swerve from the row he walks in, the driver directs the hoes in their rows, until the horse regains his former track. A steady horse will not leave the row he is placed in, from one end of the landing to the other, and only a steady one should be employed in such work as hoeing. A steady man, to steer the hoes, is as requisite as a steady horse, otherwise carelessness will send the hoes through the rows of corn plants, and cut them through as well as the weeds.

4103. In 1849, Dr Newington of Knole Park, near Tunbridge Wells, the inventor of the dibble, fig. 292, introduced to public notice a hoe, which he names a *cultivator*, for weeding and stirring the ground between the rows of corn. It consists of a shaft with a cross-handle at one end, and at the other end a shank, to which is attached a head, into which three or four or more shares are inserted at shiftable distances, corresponding with the width of the rows to be hoed, from four to eighteen inches apart—taking at one time two or three rows of the smaller distances, and one of the larger. The instrument is drawn through the ground by the force of a man, who is equipped in a canvass jacket, to which is looped a belt, by which he draws by the cross-handle. I have not seen this implement at work, but the inventor affirms that “a man can do two acres a-day with great ease; that is to say, stir and hoe an acre, from three to four inches deep, five times for 5s., much more effectually than by the present mode of hand-hoeing, and at one-fifth the expense.”

4104. For the purpose of forage the year following, Italian ryegrass (2644,) may be sown amongst wheat which has not been sown down with grass-seeds, just

before the last time it can be hoed—late in April or beginning of May—and the forage will be ready for use in May and June. A cutting of from 150 lb. to 200 lb. may be expected to be received from the square perch.

4105. Not later than May, sow, in wet weather, a top-dressing of Peruvian guano, 2 cwt. to the acre, amongst the growing wheat; or, of special manures, 1 cwt. of nitrate of soda and 1 cwt. of sulphate of ammonia to the acre. I prefer sowing top-dressings on the growing crop to sowing them on the soil along with the seed, as the plant is ready to take advantage of them immediately; whereas much of special manures at least may be washed down into the soil by rains, before the plant has arrived at the stage of growth to be benefited by them.

4106. The flowering season is a critical one for wheat, since the state of the weather at this period, which is in the beginning of June, may affect the yield to the extent of fifty per cent. Should the weather prove both rainy and windy during the whole flowering season, the produce will inevitably be scanty. Rain alone, unless it be constant, does not affect the produce so much as strong wind, which, if it blow from the same quarter, will seriously affect the side of the ear exposed to it. Showers and gentle breezes do no harm.

4107. The wheat-plant is much affected by casualties, both from insects and parasitical fungi. The young wheat-plant is not unfrequently destroyed by the wire-worm, fig. 253, which cuts over the plants by the ground. Many remedies

Fig. 355.



THE WHEAT STEM-FLY—*CHLOROPS PUMILIONIS*.

have been proposed to get rid of this pest, when so employed; but I believe none have yet proved effective.

4108. The wheat stem-fly, *Chlorops pumilionis*, fig. 355, derives its specific name, which signifies a dwarf, from the effects it produces on the plants it attacks, which, having their central shoots destroyed, throw out many lateral ones, and seldom attain any considerable height. "The colour of the fly is black," says Mr Duncan, "the under side of the head and two narrow longitudinal lines in the thorax yellow: under

side of the body pale yellow, with two black spots on the mesosternum; halteres white; the legs ash grey, and black at the tips." The maggot is small and white, the pupa yellow, smooth, and shining, rather more than one-twelfth part of an inch in length.*

4109. The wheat-fly, *Cecidomyia tritici*, was much dreaded a few years since, and its habits are now pretty well known. It is figured at *d*, fig. 223, greatly magnified, its natural size being represented by the cross lines beside the figure, and which does not exceed a line in length, resembling a small gnat or midge. Mr Duncan describes it as having "the colour of the whole body reddish yellow, deepest on the thorax; antennæ dusky, eyes black; legs pale reddish yellow; wings longer than the body, rounded at the tip, of a whitish hue, with iridescent reflections. The antennæ of the female *b* consists of 13 sub-ovate joints, those of the male *c* of 25 globose remote joints."—"The fly makes its appearance in wheat fields just about the time the ear is beginning to emerge from its leafy envelop, most commonly in the early part of June. In a calm evening they fly about in little undulatory clouds. An ear just emerging from the sheath is generally preferred as a receptacle for the eggs. They are introduced, by means of the ovipositor, into the floret, being usually placed upon the interior valvule of the corolla, just above the stigmata. The eggs are placed in clusters from 2 to 20, and are hatched in 10 or 14 days, and after the larvæ *e* begin to feed on the pollen, they acquire a saffron-yellow hue. Minute as these creatures are, when it is considered that 47 have been counted in one floret, it is easy to perceive how they must interfere with its impregnation. It is not improbable, as they increase in size, that they likewise attack the milky pulp destined for the nutriment of the grain. At all events, the grain shrivels and decays, to the grievous disappointment of the husbandman. The loss sustained by the farmers of the Carse of Gowrie, in 1829, was estimated by Mr Archibald Gorrie, Annat Cottage, from $6\frac{1}{2}$ to 16 bushels per imperial acre."—"Nature herself has provided a considerable check to the multiplication of these flies, by making them the prey of no fewer than three kinds of ichneumons, viz.:—*Encyrtus inserens*, about half the length of the wheat-fly; another *Platygaster tipule*, which commits its eggs to the larva of the wheat-fly; and the third, *Eurytoma penetrans*. Some of these ichneumons appear in great numbers where the fly abounds, and multitudes must become their victims."†

4110. Although the attack of the wheat fly was talked of as a new plague, when it occurred some years since, it would appear that it was known in Scotland in 1740, when the frost was so severe that the Thames was frozen over and an ox roasted upon it, as the observations of an agricultural writer of the time informs us. "After this," he says, "we had a melancholy sight, for as soon as the wheat had done bloom-

* *Quarterly Journal of Agriculture*, vol. xii. p. 121.

† *Ibid.* vol. xi. p. 372-8.

ing, vast numbers of black flies attacked the wheat-ears, and blowed a little yellow maggot which ate up some of the kernels, in others part of them, and which caused multitudes of ears to miss of their fullness, acting in some measure like a sort of locust, till rain fell and washed them off; and though this evil has happened in other summers to the wheat in some degree, and not done much harm, yet if the good providence of God had not hindered it, they might have ruined all the crops of wheat in the nation.* The black fly here mentioned is one of the ichneumon flies, which deposit their eggs in the larvæ of the wheat-fly to destroy them, the wheat-fly being of a reddish yellow colour; but mistaking the pest for its destroyer was natural enough at a time when the identity and habits of insects were but imperfectly understood.

4111. The wheat-plant is attacked by the larva of the wheat dart-moth, *Agrostis tritici*, under ground, feeding on the radical portion of the plant, in autumn, and never appearing above the surface of the ground except at night.

4112. As regards the attacks on wheat by parasitical fungi, the Rev. Mr Sidney defines a fungus to "be a cellular flowerless plant, deriving its nutriment by means of spawn. It lives in air, and is propagated by spores, which are naked, or by sporidia, so called when enclosed in little vesicles. The way in which these spores germinate, generally speaking, is by a protrusion of the inner membrane, or an elongation of the outer, thus lengthening out its spawn, which is the usual mode; but there is another method of germination. . . . Fungi may be said to consist of a mass of little cells, or little threads, or of both combined in various ways. They have no fructification except their spores or sporidia, of which the methods of attachment are singularly curious and beautiful. In their respiratory functions, they approach to the peculiarity of animal rather than vegetable life, for they absorb oxygen and exhale carbonic acid gas. Like flesh, they contain a great quantity of nitrogen; and the substance called *fungine*, extracted from them by the chemist, is said to bear a near resemblance to animal matter. They derive their nourishment from the substance on which they grow, and not, as is the case with the lichens and algæ, from the media in which they exist. The juices, impregnated with the peculiar principles of the matter to which any particular fungus is attached, form its appropriate food."

4113. Fungi affect both the straw and the grain of the wheat. The disease originated by them on the straw of wheat is called *rust*, from its resemblance to the rust of iron, and in the grain *smut* and *bunt*. It is a subject of reasonable inquiry to know the manner in which fungi originate diseases in crops, to the great extent experienced in those diseases of the wheat, and "the only truth-like solution of their source," as Mr Sidney observes, "is the almost universal diffusion of their inconceivably

small sporules, which are so numerous and minute that it is not easy to conceive any place where they may not abound. They are ever at hand, only awaiting suitable conditions for springing into existence. . . . They generally appear in patches, consisting of multitudes of spores, that form frequently so many cases enclosing the reproductive sporules which float in the atmosphere around us, until they light on some place adapted to their growth. Their extreme minuteness allows of their being introduced into the substance of the tissues of plants or beneath the epidermis. As they grow on the leaves or straw of corn plants, they raise the epidermis into curious puffy blisters, which they subsequently rupture. These patches are of different colours, but most commonly either deep yellow, brown, or black. The several parts of the wheat-plant are attacked by these parasitic pests, which are quite distinct from each other, having nothing in common except that they germinate within the tissues."†

4114. *Mildew*.—Mildew or blight, *Puccinia graminis*, forms blackish-brown parallel lines upon the straw, and seems to affect the entire plant; so that, when it is generally diffused over it, it deprives the sap of the power to form seed in a healthy state, and hence the grain is either very much shrivelled when it is formed, or no grain is formed at all. So generally did this disease affect the wheat crop of Berwickshire in three successive years, 1810, 1811, and 1812, when the price of wheat was at the highest rate during the war, that in many instances it was not considered worth while to thrash it. The method by which the spores of the puccinia enter the tissues of the straw of the wheat, is by its stomata or breathing pores, which are numerous. These are closed in dry weather, but are opened to receive the moisture in wet or even damp weather; and it is at this time, it is supposed, that the fungal spores enter into the plant by the stomata. It is certain, at all events, that the mildew only makes its appearance in moist warm weather, damp situations, and on over-manured land.

4115. A notion prevails in England that the berberry bush, *Berberis vulgaris*, has the power of causing the mildew in wheat, probably from the well-known circumstance that the berberry is itself very subject to mildew: but its mildew is occasioned by the *Erysiphe berberides*, whereas that of the wheat arises, as we have seen, from a *Puccinia*, and no possibility exists of transforming the one kind of fungus into the other.

4116. *Rust*.—One species of rust is found scattered over the inner surface of the outer chaff scales, the skin of which is raised into blisters, mostly of an oval form. It is occasioned by the *Uredo rubigo*, and is of an orange yellow colour, and is the worst species of rust, as it may affect the produce, if moist and cloudy weather continue for some time. The rust which affects the straw originates in the *Uredo linearis*; and when it disappears, the straw is not materially

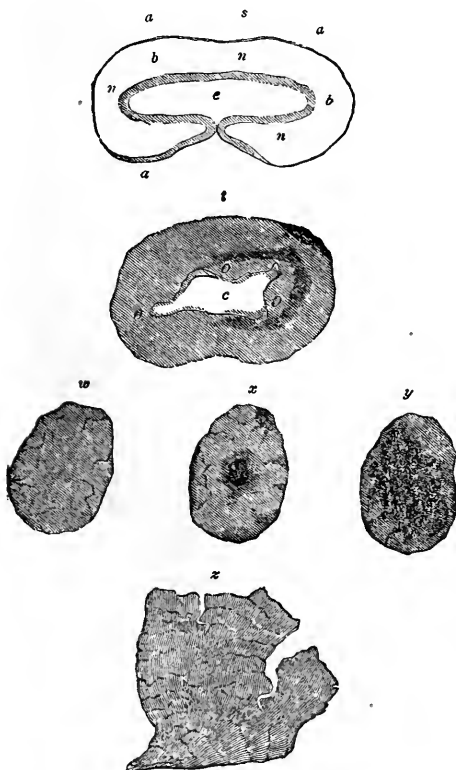
* Ellis' *Modern Husbandman*, for August 1745, p. 129.

† Sidney's *Blight of the Wheat*, p. 15 and 29.

injured, and the arrival of bright warm weather soon dissipates the evil. The genial beams of the sun completely vanquish both, so that they disappear in a surprising manner, and a healthy greenness speedily succeeds to the yellow tints that have disheartened the farmer. I have seen the leaves of wheat so much affected with yellow rust, at the time of weeding, before the ear had shot out, that the nether garments of the field-workers, who weeded the crops, were covered with orange dust. The rust on the leaves disappears in its worst form, before that on the chaff scales appears at all.

4117. *Smut or Bunt*.—The disease called in Scotland smut, is named bunt in England, and the smut of England is the black ear of Scotland. Smut, *Uredo caries*, is so well understood in its appearance and character, that it requires no particular description farther than that it is a brownish black, greasy fetid powder taking the place of the kernel of wheat. Mr Lawson of Elgin examined the structure of the smut-ball in comparison with sound wheat, and the differences in their appearances are shown in fig. 356, where

Fig. 356.



THE STRUCTURE OF SOUND WHEAT AND OF SMUT-BALL COMPARED.

s is a longitudinal section of a sound grain of wheat, in its progress towards development, when the anthers have just protruded beyond the corolla; *e* is an empty space lined internally with a greenish border *n n n*. As the grain advances, the space *e* contracts, and its substance *b b*, lying between the green border *n* and the outer green cuticle *a*, becomes filled with milky juice: *t* is a longitudinal section of a smut-ball taken when the stamens are fully formed within the corolla, for the anthers never protrude beyond the corolla when the grain is affected with smut; *c* is an empty space surrounded by a dark green substance, *o o o* which extends to the outer cuticle. In a very short time the whole interior of the smut-ball changes from green to white, as at *t*, the outer cuticle continuing green. The white substance soon has a black speck in its centre, as at *x*, which gradually spreads through the ball, as at *y*; and as the ball still advances to maturity, the dark green cuticle changes to brown, as at *z*. The green substance occupying the place of the milky juice, at once explains the difference betwixt a smut-ball and a sound grain.*

4118. *Black ears*.—Wheat, barley, and oats sometimes seem to have their young ears coated as if with soot, adhering by some gummy substance to them. Its effect is completely to destroy the grain, from the first instant it emerges from the hose. It is produced by the *Uredo segetum*, in hot blinks of sunshine in showery weather, when the ears are appearing out of their sheaths. The spores of this fungus are so small, that M. Bauer counted 49 on the hundred and sixty thousandth part of a square inch. Hence, a square inch could contain 7,840,000 of them; and if the spores are so small, what must the dimensions of the sporules be? The highest imaginable power of a microscope could only be expected to exhibit them as a vapoury cloud.

4119. *Eel of the wheat*.—"This is one of the most singular of living creatures," observes Mr Sidney; "and were its habits not thoroughly investigated and proved, they would seem almost incredible. Its attacks are confined to the farinaceous portion of the grain, which it destroys and replaces, producing the disease known by the name of ear-cockle, pepper-corn, or pimples. A grain of wheat, infected by this blight, assumes the appearance of a black pepper-corn. The whole ear is altered in appearance; the chaff husks open, and the awns become curiously twisted, so that the ears are easily distinguished from a healthy crop. The grains first turn dark green, and then black. If one of them is divided into two with a penknife, it will be completely filled with a dense, white cottony mass, occupying the place of the flour, and leaving merely a little glutinous matter. These contents seem to the eye like a quantity of fibres, closely packed together in parallel directions; but if a little morsel is taken on the end of a pin, and put on a slip of glass and moistened, it will soon be seen to divide and give a milky appearance to the water. But in submitting it to a powerful

* *Quarterly Journal of Agriculture*, vol. ix. p. 269-72.

microscope, the astonished observer will soon discover that the cottony mass is a dense body of living, eel-shaped animalcule, which often wriggle about with great vivacity. Accordingly, the name given to the disease is *Vibrio tritici*, the eel of the wheat.* I have never seen an instance of this remarkable creature. It is an infusorial animal. From the investigations of M. Bauer, it appears that, after laying all their eggs, the parents soon die; but such is not the case at an earlier period of life, for after being dried and appearing quite dead, on the application of moisture they become as lively as they were at first, and this after a period of six years and one month. It seems probable that the glutinous substance in which they are enveloped preserves their vitality.†

ON THE SUMMER CULTURE OF BARLEY.

4120. We left the barley in spring to its fate, immediately after the grass-seeds were sown and harrowed amongst it, and the land rolled, (2697.) Barley seed soon springs, in favourable weather, and sends the germ above ground, in some years, in nine days after sowing. Nothing is done with the crop until the period arrives for weeding it, and in the broadcast crop the weeds are removed with the hand weed-hook, fig. 352, or by the hand, the field-workers being arranged in the same manner as has been pointed out for the weeding of wheat in (4097.)

4121. The weeds that most infest the barley crop are the creeping plume thistle, *Cnicus arvensis*, though not to the same degree as it does oats. The charlock, *Sinapis arvensis*, frequently takes possession of the barley crop in the neighbourhood of large towns, the seeds of which are supposed to be derived from the street manure, so largely used in such localities. When this weed is abundant, the most effectual way of getting rid of it is to pull it up by hand and carry it off the field. Another weed, which sometimes appears in great quantities in light soils, is the common red poppy, *Papaver rhæas*, amongst which will be found some of the smooth-headed poppy, *Papaver dubium*. The deep scarlet-coloured flower of the former produces a striking effect, even at a distance. This weed, when in quantity, will have to be pulled by hand, like the charlock. The seeds of the sticking-grass or cleavers, *Galium aperine*, often find their way

amongst barley, from which it is difficult to remove them, and, even after undergoing boiling along with pot-barley, they retain their hardness.

4122. When the barley is drilled or dibbled in rows, the horse-hoe, fig. 353, is employed to remove the weeds, and is a more economical implement than the hand-hoe, fig. 266. Still the weeds amongst the rows of grain must be removed by the hand or hoe. When the charlock and poppy are abundant, the horse-hoe is an unsuitable implement to remove them, since, on accumulating between the hoes, the bundles of weeds will be apt to be thrown upon the rows of grain. When the horse or hand-hoe is to be used among barley, that is, when barley is sown in rows, it is needless to roll the ground after the grass-seeds are sown amongst it in spring, (2697.)

4123. Barley may be top-dressed with 2 or 3 cwt. of Peruvian guano to the acre, amongst the growing crop, and not upon the land at the time of sowing the seed, for the reasons given above in regard to top-dressing the wheat crop, (4105.) Sulphated bones, (3233) to the extent of 2 cwt. to the acre, may also be applied in a similar manner. Of the special manures, 200 lbs. of the nitrate of potash to the acre has given a favourable result.

4124. When barley is not sown down with grass-seeds, sainfoin may be sown amongst it, in calcareous soils, in April; and it will be fit for cutting as a forage crop for cows in May or June the next year.

4125. Barley is not much affected by the state of the weather in the flowering season, since that season is so much later than that of wheat, that the weather is seldom stormy for many days together—that is, much rain and strong wind at the same time.

4126. A clear liquid at times transudes from the points of the young barley plants, which is mistaken for dew. Its nature has not yet been chemically examined.

4127. Barley is subject to the attack of fungal parasites as well as the wheat, though not to the same extent or degree. Black heads in bar-

* Sidney's *Blights of Wheat*, p. 84.

† *Journal of the Agricultural Society of England*, vol. vi. p. 514.

ley appear under the same circumstances as in wheat, (4118,) and are produced by the same fungus, *Uredo segetum*.

4128. Ergot, a fatal disease well known in rye, is not unfrequent in wheat, as also in several of the grasses, such as ryegrass, meadow-fescue, cats-tail, and cocksfoot; but I had never observed the disease in barley until Mr John Lawson, Elgin, pointed it out some years ago. Ergot is a monstrous state of the seed, not induced by any fungus, so far as is known, but by some unknown cause which produces a change in the structure and form of the seed, as is observed in cases of vegetable morphology. It causes part of the embryo to be preternaturally enlarged, to protrude beyond the chaff, to assume a curved form, somewhat resembling a cocks' spur, the French for which is *ergot*. Ergotted seed is black superficially, and of a spongy texture internally, containing oily matter, so that it will burn like an almond at a lighted candle.

4129. Mr Lawson traces the change caused by this disorder in barley, in the following manner:—"For some time after a head of barley has assumed its proper form," he observes, "but before it has arrived at maturity, the corolla is not more attached to the seed than in oats, if so much. If at this early stage we examine a barley plant, it will be found that the corolla may very easily be separated from the seed, and that the seed



THE KERNEL OF BARLEY WITHIN THE HUSK.

look at the base of the barley seed, we will observe this base (within the corolla) covered with two fine membranous substances, in the form of a feather, or rather like the wings of a fly, as *e f*, fig. 358, growing out of the base *b c*. The corolla of many plants is hairy or woolly at the base, on the outside of the corolla, but these membranous appendages, both in their sound, diseased, or altered state, are in the inside of the corolla, and cover the seed. Referring to the representation of the young ergot or diseased seed of barley, fig. 358, we find a great change of structure, both in the base and its feather-like appendages. The base, in this case, is of a pure white, and firm and polished like enamel. It has also assumed a different form. In a sound seed, it is a flat oval disc, *b c*, fig. 358; in the diseased seed it has assumed the form represented by *a h*, fig. 359. The feather-shaped membranes have likewise changed their form, and instead of spreading over the flat side of the seed, have grown up in two tufts, *f n*, one on each side of the seed. I think we may conclude that the



SOUND BARLEY SEED.

production of ergot in barley arises from a change in structure which commences at the base of the seed, and which the laws that govern vegetable morphology are found in other instances to produce. I may add, that I have never seen the slightest appearance of stamens in a floret containing ergot; neither is there any appearance in ergot of the two cups or sacs which are in the sound seed. The methods adopted for preventing smut in wheat, (2307,) may probably also prevent ergot in barley."* The issue of this last suggestion may be doubted, since we have seen that smut is a fungal and ergot not a disease of fungal origin. Draining rescues the wheat plant, as also the grasses in pastures, from the attack of the ergot.

4130. Barley is extensively attacked in Sweden by the *Chlorops frit*, which destroys the principal stem; and Mr Chrisp, Rugley, near Alnwick, mentions the effects of an insect on barley, its "larva living in the sheath, and feeding upon the ear, previous to its appearance from the shot blade. Every year," he says, "I have observed more or less injury to the crop by the same cause, but it appears most serious, in a late or wet cold year, upon stiff soils."†

Fig. 359.



DISEASED BARLEY SEED.

ON THE SUMMER CULTURE OF OATS.

4131. The spring culture of the oat was finished according to the statement in (2499.) Oats require about a fortnight to braird in ordinary weather.

4132. The weeding of oats, when sown broadcast, is effected by the weed-hook, fig. 352. The oat is the first crop which requires weeding, and the weed that most infests it is the creeping plume thistle, *Oniscus arvensis*. It is perennial, and its roots creeping, by which it easily spreads itself, and, when allowed to grow, will attain the height of from one to three feet, and waft its plumed seeds over the adjoining fields. When allowed to flourish amongst corn, it is extremely troublesome to reapers at harvest. The plant should not be cut down before it has attained about nine inches in height, otherwise it will soon spring again from the root, and require another weeding; and by the time it has attained that height, the oats will be about one foot high. In using the weed-hook amongst oats, the field-workers are arranged in the same manner

* *Journal of Agriculture*, March 1848, p. 386-7. † *Quarterly Journal of Agriculture*, vol. xiii. p. 208.

as when weeding wheat and barley, (4097.) A very troublesome weed among oats, in the neighbourhood of large towns, where street manure is employed, is the wild mustard or charlock, *Sinapis arvensis*, which so completely covers the soil in moist seasons, that its bright yellow blossoms obscure the whole crop. Whether oats are sown broadcast or in drill, the wild mustard, when so plentiful, must be pulled by hand, as there is no other way of extirpating it. When oats are sown in drills, the horse-hoe, fig. 353, is employed to extirpate the weeds; but those growing in the rows of the corn must be removed with the weed-hook, from dibbled corn, and by the hand from drilled.

4133. A top-dressing of 2 cwt. of Peruvian guano to the acre in wet weather, or 3 cwt. where the soil is poor, will effect a great improvement in the growing crop, and not when the seed is sown, for reasons given above in (4105.) Of the special manures, 400 gallons of ammoniacal liquor, or 2 cwt. of the sulphate or muriate of ammonia, applied in the same manner, may be expected to give a considerable increase of crop.

4134. Oats are as little affected by the weather in the flowering season as barley is; and both being in flower about the same time, the weather must assume a stormy character for days together to injure either.

4135. The casualties which befall the oat crop are numerous. One complaint is *segging* or *sedging*, so named in consequence of the plant being short, the leaves becoming hard, and the roots thickened like those of the sedge. What the true cause of this complaint is I do not know, for any insect that may be then detected in the plant I regard as the effect, not the cause; but I have cured a piece of land of its constant tendency to grow sedged oats, simply by draining.

4136. Oats are liable, in damp warm seasons, to have black ears, when the entire panicles are clustered together, and covered with the black powder of the *Uredo segetum*, a parasitic fungus, (4118.) The blackened heads do not occur to a serious extent; but whether the disease would be entirely avoided by pickling the seed-oat, as the seed-wheat is, I cannot say.

4137. Besides being attacked by the crane-fly in spring, (2504,) oats are attacked in summer by

the dart-moth, *Agrostis segetum*, whose wings expand from $1\frac{1}{2}$ inch to $1\frac{3}{4}$ inch, and which produces larvæ that attain the length of $1\frac{1}{2}$ inch, and live upon the portion of the corn-plant below the surface. Rolling heavily at night, when larvæ generally come to the surface, may effect the destruction of some; but as all caterpillars which live in the earth have a tough elastic skin, capable of considerable resistance, such of them as have not a stone or other hard substance under them, would be merely pressed into the soil, without sustaining any material injury from rolling.*

4158. Mr Norton found the composition of the ash as follows, in the respective parts of the green oat :—

	Leaf.	Stalk.	Knots.	Chaff.	Oat.
Potash and soda,	18.35	42.43	39.21	15.39	31.37
Chloride of sodium,	0.90	4.46	0.60	2.01	0.61
Lime,	5.13	4.12	4.75	4.58	6.76
Magnesia,	1.63	1.47	4.51	3.10	2.94
Oxide of iron,	0.55	0.62	1.02	1.50	0.35
Sulphuric acid,	13.05	7.84	27.94	9.90	16.42
Phosphoric acid,	2.91	6.31	9.03	7.25	15.19
Silica,	58.22	34.85	13.23	56.33	26.05
	100.14	102.10	100.29	100.12	99.65

On the 16th July the plant was in the midst of its most rapid growth, and just half way between the time when it appeared above ground in June, and when it was cut on the 3d September.

4139. Dr Fromberg determined the nitrogen in the unripe oat, at six periods of its growth, as follows :—

	July 16.	July 30.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.
PERCENTAGE OF NITROGEN.						
In undried oat,	0.51	0.53	0.62	0.66	0.97	1.52
dried	1.71	1.35	1.38	1.31	1.79	2.20
PERCENTAGE OF PROTEIN COMPOUNDS.						
In undried oat,	3.24	3.24	3.90	4.15	6.10	9.58
dried	10.75	8.50	8.69	8.25	11.96	13.84

The steady increase of nitrogen from the 30th July is very striking.†

ON THE SUMMER CULTURE OF RYE.

4140. Hitherto we have said nothing of the culture of rye; and the reason is, that as it is always sown in autumn, no occasion has occurred for speaking of it until its culture in summer demands a few observations.

4141. As rye runs through its courses rapidly, and comes early to maturity, the

* *Quarterly Journal of Agriculture*, vol. xiii. p. 162-7.

† *Transactions of the Highland and Agricultural Society*, July 1846, p. 329.

straw attains a considerable height before the ordinary weeds make a formidable appearance. The weeds most common amongst rye are those found upon light soils, as the sheep's sorrel, *Rumex acetosella*, and the corn marigold, *Chrysanthemum segetum*; and these are easily removed with the weed-hook, fig. 352, when young, or pulled by hand when farther advanced in age.

4142. Rye is so very little cultivated in Great Britain, that it is rarely to be seen in our fields. On the continent of Europe it is, on the contrary, much cultivated, as it forms the staple food of the people; and as a large proportion of the soil in the north of Europe is sandy, "rye may therefore be regarded," as Thäer well observes, "as the most precious gift of God to the inhabitants of sandy and poor countries; without it many districts would have been uninhabitable." Advancing early to seed, the flowering season is a more critical period for rye than for any of the other cereal crops. A white frost occurring at this time may partially, or even wholly, prevent the formation of the grain; and where this has been the case, the ear loses colour, the points of the husks pucker up, and they are found to be empty. "Rainy, damp, or very windy weather occurring about the flowering season," says Thäer, "has a pernicious influence on rye. Occasional showers do it no harm, even when they are tolerably frequent, provided that there are a few hours of warm sunny weather between each; for during the rain the rye closes up its valves, and when the sun afterwards comes out, the anthers spring up so vigorously that the pollen from the stamens covers the field like a thick cloud. But during continuous rains the anthers undergo an alteration in the valves, and rot; or at any rate impregnation does not take place; or, if it does, the embryo of the grain is putrified and lost. It is thus that the disease termed the spur or ergot of rye is engendered, and that curious, blackish, violet-coloured excrescence formed which is so well-known, and of itself appears to be of no consequence, but when swallowed

in large quantities, and especially while fresh, occasions such dangerous and mortal diseases in both men and animals." *

4143. The correct definition of the ergot of rye is this:—"The ergot is a kind of spur which issues from the grain of rye. It is elongated and curved, marked with three blunt angles and longitudinal lines. Its colour is violet of different shades. Internally it has a dirty white colour. When collected in quantities, it emits, while fresh, a disagreeable smell. Its taste is slightly biting and nauseous. Its length is about an inch and a half, and its thickness about a quarter of an inch."† De Candolle considered it a species of fungus to which he gave the name of *Sclerotium claris*; others name the fungus *Sphacelia segetum*; and some consider it as a morbid alteration of the ovarium of the rye, caused by the puncture of an insect of the genus *musca*, and which deposits a blackish liquid. It is unnecessary to pursue the inquiry into the origin of this disease, after what has been already said on the ergot of barley in (4129.)

4144. The composition of the ash of the ergot of rye is as follows, according to Engelmann; that of the substance itself has not yet been chemically examined:—

Potash,	45.38
Soda,	16.79
Lime,	1.68
Magnesia,	5.34
Oxide of iron,	2.34
Phosphoric acid,	15.44
Sulphuric acid,	0.02
Chlorine,	2.36
Silica,	15.60

104.95

Percentage of ash, 0.35‡

4145. Dr Taylor observes, that "some toxicologists rank this substance among narcotico-acrid poisons: others exclude it from the three classes, regarding it as a poison *sui generis*. Although its effects are in some instances peculiar, yet, when taken in large doses, the symptoms produced very much resemble those caused by the vegetable irritants. Its effects vary according to whether it be taken in large doses, or whether its use be long continued in small doses. The results of numerous experiments on animals, and some observations on the human subject, show that ergot administered in a large dose in any form, (about 2 drachms of the powder,) is liable to occasion dryness and irritation of the throat, salivation, thirst, burning pain in the stomach, vomiting, cholice, and sometimes diarrhoea. Cerebral symptoms, such as headach, giddiness, and stupor, are also met with. The appearances after death have been, in a few cases,

* Thäer's *Principles of Agriculture*, vol. ii. p. 421—Shaw and Johnson's translation.

† Thomson's *Organic Chemistry—Vegetables*, p. 879.

‡ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 402.

patches of inflammation on the mucous membrane of the stomach and small intestines.

4146. "The chronic effects of this poison have been witnessed occasionally on the Continent in an epidemic form, and they have in some instances been distinctly traced to the admixture of ergot with rye-bread. Serious effects are not witnessed in this country where rye-bread is but little used; and even on the Continent this condition, to which the name *ergotism* has been given, requires for its production a very long-continued use of the diseased grain. M. Bonjean has given an account of two instances, in which spontaneous gangrene was brought on by bread containing ergot. One child was ten years old, and it was found necessary to amputate both legs; the other, between two and three years old, lost the right leg by spontaneous separation.

4147. "The ergot, it is well known, is largely employed by accoucheurs to aid parturition, and indeed to bring it on. Much difference of opinion exists as to the abortive powers of this substance: some regard it as only acting on the uterus by the production of great constitutional injury, and that its effect is simply to accelerate but not to induce labour. In many instances it has been found to bring on a violent action of the uterus at an advanced stage of gestation, or when efforts at parturition had already commenced. The results of experiments on animals lead decidedly to the conclusion that ergot exerts a specific effect on the uterus, and the observations of Mr Youatt fully corroborate this view. The conclusion appears to me to be, that, although in some instances ergot, even in large doses, may fail to excite uterine action, yet that in other cases it appears to act decidedly as an abortive, and to originate this action." * Ergot exercises frequently a fatal action on the heart of the fetus. In a summary of cases given by Dr Hardy, it appears that in 48 cases, when ergot of rye had been given, 34 children were still-born.† Ergot should therefore be very cautiously given to any animal in labour.

ON THE SUMMER CULTURE OF POTATOES.

4148. The harrowing of the tops of the drills of potatoes, with the drill-harrow, fig. 220, giving liberty to the potato germs to penetrate the ground in an upright direction, (2790), the germs may be expected to appear above ground in a fortnight or three weeks after being planted, according as the state of the weather had been favourable to vegetation or otherwise, and according to the early or late period of the season in which they were planted; the later the season, the quicker the vegetation.

4149. After the plants have attained three or four inches in height, the scuffler, fig. 262, ought to be passed between the drills to remove the weeds that may have grown. The field-workers then use the hand-hoe, fig. 266, to remove all weeds growing close to and between the potato plants; and to remove any clods that occupy the spaces between, or that bear upon the plants. After a little time, the drill-grubber, fig. 264, goes along the drill, to destroy the fresh growth of weeds.

4150. The potato crop is not so much infested with the wild mustard and radish as the turnip; but in consequence of the ground being obliged to be early prepared in spring, there is not sufficient time to destroy couch-grass, and the oat-like grass, commonly called knot-grass. The weeds that frequent the potato ground are pretty numerous, because the stems of the potato plant, permitting the air to pass between them, and the ground being usually in good heart, and there being plenty of room between the rows of plants, weeds get up after the operations of the plough have ceased, and they are usually these:—white goose-foot, *Chenopodium album*; common fumitory, *Fumaria officinalis*; mugwort, *Artemisia vulgaris*; chicken-weed, *Stellaria media*; nipple wort, *Lapsana communis*; shepherd's purse, *Capsella bursa-pastoris*; ivy-leaved speedwell, *Veronica hederifolia*; small annual nettle, *Urtica urens*; all on their respective soils.

4151. Another hand-hoeing is given to remove the weeds between the plants, but chiefly with the view of stirring the ground well around them. As to the setting up of potatoes with the double-mould board plough, fig. 209, they require to be set up in all soils, because, being tubers occupying the ground below the surface, the earth should be loosened and heaped about them; and as potatoes grow in clusters around the stem near the surface of the ground, and even above it, it is requisite to cover these, as they would be too much exposed to the air, and become green and bitter; but it is possible to set up potatoes so as to injure them, which is always the case when the earth is not put

* Taylor *On Poisons*, p. 537-40.

† Murphy *On Natural and Difficult Parturition*, p. 141.

on the top of the drill, and when the plough goes deeper than the dung in the drill. On light land the last practice is useless, and on damp heavy land, it has the effect of enclosing the tubers in encrusted drills. An interesting experiment on the depth to which potatoes should be earthed, was made by Mr Peter Mackenzie, Plean, near Stirling. "On well-drained land," he says, on describing the results of the experiment, "three modes of cultivating the potato were tried; the dung used being what is called well-made farm-yard manure. The first was similar to the plan usually adopted—namely, earthing up the crop, until the interval between the rows was 2 or 3 inches deeper than the roots and dung. The second plan differed only from the first in being less earthed, or what may be called by some a half setting up. The third mode had no earth drawn to the stems of the plants, and the earth was only hoed between the rows. The dunging of the crop and the distance between the rows were equal. When the potatoes were dug, the advantage of the second mode of culture over the first was fully more than one-third part of the increase, and better in quality; for the potatoes grown by the first plan would not bring the same price in the market which the second did. The produce of the third plan was nearly equal in bulk with the second, but rather inferior in quality, many of the potatoes having their sides *greened* by being exposed to light. While growing, the second and third lots had a much more healthy appearance than the first; and when dug, what remained of the dung that was used was well mixed with the soil; while the dung of the first lot was dry and little decomposed, clinging in clusters to the roots of the potato plants when they were dug. It would be little trouble for farmers and others who grow the potato," advises Mr Mackenzie, "to try the experiment on land that has been well drained; for it would certainly be a great advantage to themselves if they could increase their potato crop one-third more than is usually grown on the same extent of ground, and with less labour to themselves and horses. When we bear in mind the number of acres still planted with potatoes, it must greatly increase the food of the country, both for

man and beast, if 120 or 180 bushels were added to every acre in the produce of that essential article of food; when we remember the number of square feet in an acre, and if, upon every square foot, an extra potato were raised, weighing only a quarter of a pound, more than 4 tons would be added to the crop on every acre." * It stands to reason that the moderate method of earthing up potatoes is preferable to the very deep one usually practised in the country. For this purpose, the setting up double-mould-board plough, fig. 214, would be better than the common double-mould-board plough, fig. 209, its mould-boards being cut away below. The earthing up is frequently too long delayed, even after the plants have nearly met across the drills: it should be finished before the plants have advanced so far in growth; but still it should not be begun until they carry their stems and leaves to some height above the ground.

4152. A top-dressing of 2 cwt. of Peruvian guano to the acre, in damp weather, applied by hand by field-workers near the plants, after the earthing up of the crop has been finished, will greatly increase the produce; 48 bushels of soot to the acre have also been found of service; and of special manures, 1 cwt of the sulphate of soda and of the nitrate of soda each, has had good effect.

4153. It has frequently been alleged that when the blossoms of the potato plant are removed, the potato crop is increased. The late Mr Knight says, that there are facts "sufficient to prove that the same fluid, or sap, gives existence alike to the tuber and the blossom and seeds, and that whenever a plant of the potato affords either seeds or blossoms, a diminution of the crop of tubers, or an increased expenditure of the riches of the soil, must necessarily take place. It has been proved by others, as well as myself, that the crop of tubers is increased by destroying the fruit stalks and immature blossoms as soon as they appear." As a recent instance of such proof, Mr W. H. Tighe, Woodstock, Inistogue, cut the blossoms off one drill of strawberry red potatoes, and left them on another drill, hard by, and the results, on the 13th of October 1849, were, that

* *Quarterly Journal of Agriculture*, vol. xiii. p. 363.

from a perch of the drill from which the blossoms were cut, he received 2 stones 5 lb. of potatoes, which were all good, while from the perch of the other drill on which the blossoms were left, the produce was only 1 stone 9 lb., a few of which were bad.* Since the sap which forms the tubers and blossoms is derived from the same source, "the cause why early varieties of the potato do not afford blossoms is the preternaturally early disposition of the plant to generate its tuberous roots."† Since the time the potato disease has established itself in this country, it has been observed that the potato plant puts out blossoms less plentifully than it did before. The scarceness of the blossoming has not been found to be accompanied with any increase of produce; and the result is not surprising, since plants that put out weak tubers must put out weak blossoms, or fail to put out any at all.

4154. Professor Johnston states, that "by taking off the blossoms of potatoes—besides the usual increase of crop—the tops keep green till the potatoes are lifted. Thus much green matter is obtained; and if this be made into manure, and applied to the next potato crop, it is said to raise the largest produce of tubers."‡ "By every ton of potato-tops," says Dr Fromberg, "we add to the land about 50 lb. of inorganic salts and a quantity of organic matter, containing 20 lb. of nitrogen, or about 23 lb. of ammonia; this being probably the form under which the nitrogen is gradually discharged in the decomposition of organic matter."

4155. I have already alluded to the baffling nature of the potato disease, and of the many opposite expedients which have been tried simultaneously in different parts of the country to evade its attack, without success, from (2778 to 2781.) In the present uncertain state of the culture of the potato, one is justified in trying every plan, whether suggested by practical or non-practical men, particularly by the former, which has been said to have succeeded, or is likely to succeed. Two new plans of culture have been suggested

in 1849, one by a Scotchman, another by a Belgian.

4156. The first was suggested by Mr David Martin, Muirhead of Liff, near Dundee, who recommends the seed potato to be cut lengthways, not across, that some of the eyes of the rose end may be in every set; that the drills be fully one yard wide, to allow of the future culture being conducted in the best manner; that, as soon as potatoes are formed, the shaws or stems should be bent down over one side of the drill, and the earth brought over the shaws on the other side, as high as until the drill is like the roof of a house with the shaws growing out of one side of it; that when the shaws are in this position, the rain is not conducted to the potato, but to the bottom of the drill. The cost of the earthing up does not exceed above one penny the perch. Mr Martin says that he has tried this plan for three years with perfect success, not having a diseased potato all the time. In 1848 he tried alternate drills of his plan with the ordinary one, and in every case his plan afforded sound, while the common one gave nothing but diseased potatoes.§ The success of this plan has been corroborated by a correspondent of the *Gardener's Chronicle* of the 8th September 1849.

4157. The Belgian plan was suggested by a farmer, M. Tombelle Lomba of Namur, and it consists in cutting off the stems as near the ground as possible, after the flowering is over, with a sharp instrument, such as a sickle, so as not to disturb in the least the potatoes in their bed, and then to cover up the incised stumps of the stems with at least half an inch thick of earth, to perhaps two inches thick. The rationale of this process, as explained by Dr Lindley, is, that it may be that potato-tubers, after having arrived at a certain condition, possess the power of continuing their growth by their own proper and unassisted vitality; and this is rendered the more probable by the well-known fact that the flour which gives them their principal value does not descend directly from the leaves as flour, but is in the first

* *Gardener's Chronicle*, 13th October 1849.

† Knight's *Horticultural Papers*, p. 133 and 321.

‡ Johnston's *Elements of Agricultural Chemistry*, 5th edition, p. 161. Note.

§ *Dundee Courier*, 28th February 1849.

instance of the nature of gum, or some other fluid organisable matter formed in the leaves, and sent downwards into the tubers. Having reached the tubers, it undergoes its final change, and from a soluble substance is gradually converted by their vital force into insoluble flour. To that final operation we have no reason to suppose that the leaves contribute; all that they do is to produce the matter out of which the tubers generate the flour. It must be observed that Mr Tombelle Lomba does not cut off the stems till after flowering. It is possible that at that time the leaves of the potato have done their work, as far as the tubers are concerned, and that their farther duty is to nourish the tubers. If so, we have an explanation of the result of which M. Lomba so positively speaks. This plan was tried by Mr H. Dooville, Alphington, near Exeter, in 1849, and related by him in the *Gardeners' Chronicle* of the 15th September 1849, by which it seems he succeeded in securing the potatoes in a sound state, even after the leaves had indicated symptoms of the disease; whilst those in the adjoining rows, left untouched, presented a considerable proportion of disease.

4158. But the part of M. Lomba's plan which is remarkable, is "that when the potato stems are cut off with a sickle properly sharpened," to use his own words, "the tubers are not at all interrupted in their growth; that they remain attached to the stem until they are ripe, just as if the haulm had not been removed; and that they acquire as large a relative size as potatoes which have not undergone the operation. I have so often observed this continuation of growth, that I can speak positively to its going on without the least interruption, and that the treatment which I have recommended is not attended by any loss whatever of size or quality. I can offer the most positive assurances as to this." It would appear, then, that the leaves are not necessary for the growth of the potato after the plant has done flowering. Mr Dooville's experiments were not so successful in establishing this point as of that of the soundness, for, in taking up two rows, the stems of which had been

cut off, he obtained 83 lb. of potatoes in 55 feet length of the rows; on two adjoining rows, of which the stems had not been taken away, he obtained 129½ lb. of potatoes in the same length of rows; and at Lodsworth an experimenter obtained, under the same circumstances, 88 lb. of potatoes from plants whose haulms had been retained, while from those whose haulms had been cut off he only received 68 lb. Whatever may have been the cause which produced these unfavourable results, it seems certain that, to produce results similar to those affirmed by M. Lomba, some peculiar management in the culture is required; and the point to be attended to seems to be, that the haulms should not be removed until after the plants shall have produced their flowers. If Mr Knight's views in regard to the effects of removing the flowers from potato plants, be correct, (4153,) M. Lomba's plan must have the effect of preventing the increase of the crop as far as the removal of the flowers gives it a tendency to increase.

4159. The composition of the ash of the potato leaves and stems is as follows, according to Dr Fromberg:—

	White Buffs.		Red Buffs.	
	Stems.	Leaves.	Stems.	Leaves.
Potash,	31.15	17.27	33.32	18.63
Soda,	5.80	..	3.78	4.58
Chloride of potassium, . . . . .	..	4.98	..	19.72
.. sodiuu,	21.60	14.85	21.03	2.39
Lime,	19.13	26.98	20.14	26.09
Magnesia,	5.69	6.04	4.39	4.59
Oxide of iron,	1.43	3.70	1.34	3.50
Sulphuric acid,	5.56	5.76	6.02	7.19
Phosphoric acid,	6.90	14.94	5.51	9.29
Silica,	3.34	5.48	2.37	3.22
	100.00	100.00	100.00	100.00*

4160. Professor Johnston came to these conclusions:—That in the leaves the proportion of ash diminished as the plant grew, while in the stem it increased; that the proportion of phosphates and of silica in the ash of the leaf was much greater than in that of the stem; that the proportion of alkaline matter in the ash of the leaf remained nearly stationary, while in the stem it diminished as the plant grew; that in both the proportion of silica diminished, while that of lime and magnesia increased.†

4161. No one has yet succeeded in explaining the origin of the potato disease, or even what it really is. Amongst other endeavours at explana-

* *Transactions of the Highland and Agricultural Society*, March 1847, p. 688.

† *Johnston's Lectures on Agricultural Chemistry*, 2d edition, p. 435.

tion of this mysterious subject, the interference of that singular class of beings—the fungi—has been pressed into the service, but with as little success as the more obvious intermeddling of insects. That innumerable myriads of the sporules of fungi are constantly afloat in the air is most certain; but unless they find suitable matrices of growth, they cannot vegetate and produce fungi. Is the potato, prior to disease, a suitable matrix? Of the kinds of fungi most common in organic matter, the *Botrytis* is the most remarkable; and the singular connexion of the *Botrytis infestans* with the potato disease of 1845 and 1846, will render it ever memorable. "To say that the disease was caused by this fungus," as has been observed by Mr Sidney, "would be contrary to the best evidence; but that it attends and accelerates it is unquestionable. True it is that whole fields, in a sad condition of disease, were seen without a trace of botrytis; but in all contagion, infection, and inoculation, anomalies constantly occur. In most cases, the botrytis was entirely connected with the disease, and a description of its growth will be interesting to every reader. The threads of mycelium interwove themselves amongst the cellular tissue. They ran through the loose intercellular passages of the lower surface of the leaf with great ease, and the fungi emerged through the stomata. It is a remarkable circumstance, however, that this botrytis was found to grow with greater luxuriance on the diseased tubers, where the tissue is far more dense than in the stems and leaves. That the mycelium of the fungus was contained in the diseased potatoes, may be proved from the following singular circumstance:—A quantity of silk was, during the early part of the summer of this year (1846,) perceived to be greatly damaged by a white mould. On submitting a portion of it for examination, to an individual eminent for a knowledge of fungi, it was at once pronounced to be the *Botrytis infestans*, or mould of the diseased potato. The mystery was soon cleared up; for the silk had been dressed with starch from potatoes, and proved a favourable situation for the development of the fungus from the spawn that was in it. Growth in such cases is extremely rapid; and when a potato plant is attacked by the botrytis, of course the juices are consumed by it: the elaboration of sap in the leaves cannot go on, nor, from the stoppage of the stomata by its threads, can admission of air, or emission of any gas or fluid, take place. It is certain that the disease which destroyed such quantities of the potatoes in America, Great Britain, and over the continent of Europe, has not yet been satisfactorily explained. Further researches, in plants more recently infected, may throw additional light on the important subject. Undoubtedly, in most instances the fungus appeared; and where it was not actually seen externally on the leaves, it seems to have exercised an influence on the tubers, which are, in fact, branches or stems under ground, as every botanist knows."*

4162. Yet positively as Mr Sidney affirms

that the mould cannot be the cause of the disease in the potato, the Rev. Mr Berkeley, than whom no higher authority exists in this country on the nature of that mysterious class of plants—the fungi—expresses his belief in these words, of mould being the cause of the disease:—"The decay" [in the potato,] writes Mr Berkeley, "is the consequence of the presence of the mould, and not the mould of the decay. It is not the habit of the allied species to prey on decayed or decaying matter, but to produce decay—a fact which is of the first importance. Though so many other species have this habit, these have not. The plant then becomes unhealthy in consequence of the presence of the mould, which feeds upon its juices and prevents the elaboration of nutritive sap in the leaves, while it obstructs the admission of air and the emission of perspiration. The stem is thus overcharged with moisture, and eventually rots, while every source of nutriment is cut off from the half-ripe tubers. It would be as reasonable to say, with our knowledge of the nature and habits of the cereal fungi, that bunt, or mildew, or the other allied diseases which affect corn, are the consequence and not the causes of disease. In favourable seasons they are not developed; in unfavourable seasons they spread like wildfire: in one sense, therefore, the atmospheric conditions are the cause, but merely as they stimulate into action the latent pest. The immediate cause of disease is the fungus which preys upon the tissues of the corn. So exactly, in the present instance, as far at least as the aerial portions of the plant are concerned, the botrytis is the immediate cause of destruction. In some instances it may have been aided by unseasonable frost, but this has certainly not always been the case. The mould indeed would not have spread, but from peculiar atmospheric conditions favourable to its growth. What these are it may be impossible to say; but it is a fact well known to every student of the extensive tribe of fungi, that their growth, and especially their numbers, depend more than all other vegetables on atmospheric conditions, or what Fries has happily called 'cosmica momenta.' Even the peasant knows this to be the case with mushrooms. Dry and wet summers occur, and both are equally barren; while in other seasons, apparently but little dissimilar, they occur in the utmost profusion. A species will be most abundant for a year or two, and then for a period vanish entirely. It is notorious that this is the case in other parts of the creation, especially amongst insects, peculiar species of which sometimes swarm to such an extent as to baffle the naturalist. In the summer of 1826, for instance, *Vanessa cardui* existed in the greatest profusion in England, and it was traced by Mr Way from England to Nice. The species of late years has been comparatively rare. There is nothing surprising, then, in the fact of the immense prevalence of a parasitic mould. No one wonders when the hop grounds are ravaged by their peculiar mildew, because the cultivation of hops is so limited; but if it were as universal, and of as much importance as potatoes, the ravages would

* Sidney's *Blights of the Wheat*, 145-8.

equally excite attention. It is by these instruments, contemptible in the sight of man, that the Almighty is pleased sometimes to accomplish his ends. Instances, like that of the Hessian fly, will readily occur of the immense disproportion between the means and the end."*

4163. Although the potato plant, like the other cultivated plants, is the abode of many kinds of insects, yet it is perhaps less injured by them than those plants; and I express myself thus in perfect recollection of the sensation endeavoured to be raised by Mr Smee, a few years ago, against the *Aphis vastator* as the originator of the potato disease; but the truth is, that in no instance has the aphid been seen on the potato plant in sufficient numbers to injure the produce, far less to destroy the crop. The larva of the heart-and-dart moth, *Noctua exclamatoris*, eats the haulm through just beneath the earth, and the plant in consequence fades. It also attacks the potato itself; and so insensible is it of cold, that so late as the 20th November it has been taken out of potatoes quite alive. When potatoes are left in the ground all winter, they will attract all the wire-worms, fig. 253, in the neighbourhood towards them, and of course suffer damage. When potatoes become decayed under ground, scolopendræ, *Lithobius forficatus*, and rove-beetles, *Oxytelus nitidulus*, subsist upon the corrupting mass; and when they are affected by any fungus, the kind of mite called *Oribates castaneus* will surely congregate for the sake of feeding upon the botrytis and other fungi. A rotten potato seems to be a favourite receptacle for very many insects. "I may mention," says Mr Curtis, "that from one growing and partially rotten potato, I bred, in August 1845, 128 flies, independent of many more which had died in the pupa state, or been destroyed by damp and mites, before I discovered them in the vessel in which the tuber was placed, as well as a multitude of smaller flies."†

ON SUMMER-FALLOW.

4164. Summer-fallowing is the operation of cleaning that part of the land which does not bear a crop in the season it is cleansed, and the summer-fallow is the land so cleansed. Although summer-fallow occupies the same division of the farm as green crops—turnips, potatoes, tares—yet it may most characteristically be regarded as the first preparation for the crop of the following year; it is a transference of a portion of the land, with the labour bestowed upon it, from one year to another; it forms the connecting link between one season and crop and another. But although the preparation of the soil,

for a part of the crop of two consecutive years, is conducted simultaneously on the fallow-break, yet the crops which occupy the soil thus simultaneously prepared, are committed to it at very different periods, the green fallow-crops being sown early in summer, while the sowing of the bare-fallow crop is delayed till autumn; so that, before the latter makes its appearance above ground, the former have almost advanced to maturity. Since the crop on the bare-fallow is delayed until autumn—till the eve of commencing another agricultural year—the practical effect of the delay is to dispense with a crop for a whole year on the bare-fallow-break, and it is on this account that such a fallowing is called a *bare-fallow*. As an entire crop is dispensed with in bare-fallowing, it should impart such advantages to the land as to compensate for the rest and indulgence which it receives—and such are the advantages felt from it on some sorts of soils: and the reason that the land receives such indulgence is, that it cannot carry a green or summer crop; and if it cannot bear *them*, it must be operated on so as to bear a crop that will come to perfection, and pay the expense of the fallowing. The sort of soils bare-fallowed are heavy clays; and why will *they* not bear green summer-crops? A satisfactory reason cannot be given; but experience proves that their nature is unkindly to the growth of bulbous plants used in a green state; and their heavy, wet, and obdurate nature prevents them, at any rate, from being prepared in time for sowing such plants. Could clays be altered in their nature by any means, they might be employed in raising summer-crops as well as the naturally more kindly soils; and such a change has been effected on many clay soils which were formerly incapable of rearing green-crops, by thorough-draining, skilful tillage, and liberal manuring and liming. In this way the bounds of bare-fallow have been much circumscribed, and those of green crops as much extended. Still the heavier class of clays—the deep alluvial ones—have not yet been ameliorated to the degree of bearing green-crops profitably, so they must continue to be bare-fallowed; but part of even the ameliorated soil of almost every farm is necessitated

* *Journal of the Horticultural Society*, vol. i. p. 23.

† *Journal of the Agricultural Society of England*, vol. x. p. 102.

to be bare-fallowed, for want of an adequate supply of farm-yard manure. Farms in the vicinity of large towns may be amply supplied with extraneous manure, to make up for the deficiencies of the farm-yard; but as most farms are beyond the reach of such assistance, it may be alleged that bare-fallowing, to some extent, must be practised every year upon every farm: though the limits of compulsory fallowing have been much circumscribed, of late years, by the purchase of extraneous manure from distant sources, as guano and bone-dust, and sulphated bones, which are easily conveyed, and sold at prices that afford a profit. These manures, superadded to draining and deep-ploughing, have afforded the power to cultivate green-crops upon soils which were naturally unfit for them; and, without such auxiliaries, soils even suitable for their growth would have been obliged to be bare-fallowed, to allow time to collect the requisite quantity of manure. Until manure, which is now procurable, is procured in sufficient quantity, bare-fallow must exist; and wherever that shall be accomplished, bare-fallow will be dispensed with altogether. But a natural obstacle exists against the increase of manure on farms themselves; for it so happens, that the largest quantity of straw, which is one great domestic source of fertilising manure, is afforded by land the least fitted for green crops; and the land best fitted for them affords the smallest quantity. Turnip-soils cannot supply as much straw in the state of manure fit to be applied to green crops, for little more than one-half of the fallow-break; whereas clay soils afford as much of it in the state in which the manure may be applied to bare-fallow, as sufficiently to manure the fallow-break.

4165. The land to be bare-fallowed should be the strongest on the farm, be foulest of weeds, if any there be, and be situate farthest from the steading, that the carriage of the green-crops to it may be the shortest distance practicable. The fallow land is the last ploughed in winter, and it should be so the same as for potatoes (2733) and (2734.) If one furrow—that of two out-and-two-in, (760) fig. 25.—has been given to the fallow-break after cross-ploughing, (2613.) it will be as much

as time will afford from working the potato and turnip land; and should the fallow-break not likely be worked for some time, it is better to let it lie in the rough state from the plough, than to harrow it smooth; because, dry weather ensuing, will more easily ameliorate rough than smooth land; wet weather will render rough land less tough to work than when it is compact and smooth. When leisure from the turnip-land permits attention to be paid to the fallow-break, its *state* should be particularly examined. Should the weeds in the soil consist principally of fibrous and fusiform-rooted plants, they will be easily shaken out by the harrows in dry weather; but should the roots thread themselves through the hard round clods, they will not be easily detached, and will require considerable skill and labour to do it. Inattention to the *state* of the weeds causes much unnecessary work in the subsequent part of summer-fallowing. If clods, containing portions of running roots, are knocked about in dry weather, they may be broken into smaller ones; but so will the roots in them, and the land be as far as ever from being clean. In a case of such frequent occurrence on strong land, the best plan is to allow the roots to grow for a time, and the force of vegetation will break the clods, or render them easily so by a clod-crusher, after a shower of rain shall have nearly penetrated them. A caution in the use of the *roller* should here be given. If the soil is in fine mould, rolling the hard clods will only bury, not break them. If the soil is not firm, harrowing the clods two or three times will break them better than rolling; but after a long rest, the soil is not likely to be too soft at this time for the roller. After a good clod-crushing, the land should be harrowed a double time, first one way, and then across that. The weeds may then be picked from the surface. It is not expedient to gather them immediately, as a good deal of fresh soil adheres to them. A day or two of drought should intervene, and the soil will then be easily shaken free from them with the hand.

4166. It has been recommended by writers to gather the weeds off fallow-land by a raking implement, such as the American hay-rake, fig. 351; but every

instrument of the kind will rake together clods as well as weeds, and should they be carried away with the weeds, the land will be impoverished by the loss of its finest soil. In collecting weeds, the field-workers should be ranged in a row as when weeding corn, two on every ridge, and every two to throw the weeds into the same heap; and the heaps should be rowed as far asunder as to allow a cart to pass between them, to take away two rows at a time. Many writers recommend the weeds to be burnt on the ground. No doubt, weeds will burn readily enough when dry, and their ashes constitute good manure, but, for my part, I never saw weeds so thoroughly burned on the land, as to prevent them rendering the land again foul. I agree with Lord Kames, that it is better to make a vegetable compost of weeds, than to destroy them by incineration, and demand with him, "What better policy than to convert a foe into a friend?"

4167. The weeds most troublesome to fallow-land are couch-grass, *Triticum repens*, and oat-like grass, *Arrhenatherum avenaceum*, var. *bulbosum*. There is no getting rid of either of these but by hand-weeding, which ought to be very carefully done, otherwise the breaking off the smallest portion of the root of the couch-grass, or a bulb of the oat-grass, leaves in the soil the origin of a future plant ready to propagate many around it. The annual meadow-grass, *Poa annua*, is a very common weed in cultivated soils, but its tufty plants are easily shaken out of the soil, and it only propagates by seed. In damp soils, in strong land, the common colts-foot, *Tussilago farfara*, is a weed which cannot be eradicated. The only way of getting rid of it is constantly to cut off the leaves as they grow up, and the plants will die out, or by trenching the soil and picking out the roots. On light soils, the rest-harrow, *Ononis arvensis*, is a pest, which must also be hand-weeded.

4168. It is impossible to determine beforehand how many times fallow-land should be ploughed, harrowed, grubbed, fig. 215, and clod-crushed, fig. 243 and fig. 246, to render it clean; but it should be borne in mind, to incur the least expenditure of labour in fully accomplishing the object of fallowing, which is to make

the land quite clean. It was once the practice to work fallow land until it was reduced to the state of meal; but experience has established that it is better for the ensuing crop of wheat to preserve a good-sized clod upon the surface of the ground in winter, however much the ground may be otherwise pulverised. The land must have been very foul, the weather remarkably unpropitious, or much time wasted, if the fallow-land is not ready for the manure by the beginning of August, or before the chance of harvest interfering with the process of manuring.

4169. The manure to be laid on the fallowed land, is that part of the farm-yard manure which had been left over in the courts at the time the dung was taken out of them for the turnips, (1999.) The dung that had been made by the cattle and horses after that period, is now available. Whatever compost there is to spare (2043) is now used. The clearing out of every receptacle that contains materials convertible into manure, such as ash-courts, privies, cess-pools, liquid-manures, pigeon-house, poultry-houses, ponds, ditches, rubbish, and the like, is done at this time. These materials are compounded together with the farm-yard dung, straw, or compost on hand, and made into a large dunghill in the compost-yard, Plates I. and II., where it should be prepared to be ready to apply to the fallow land by the end of July. The dung is not fermented so much for bare-fallow as for turnips, because it has time partially to decompose before the wheat is sown; but should there not be time for that, it should be fermented the more that the wheat may not stand all winter on ground hollowed by unfermented dung.

4170. The usual preparation of bare-fallow land for laying dung upon, is to fear it into ridges, fig. 19, (742) If the land has been drained, which it ought to be, the fearing should be made for casting the ridges together, fig. 22, (755;) and as the land will be again ploughed for the seed-furrow, when the wheat is about to be sown, the fearing for casting the ridges for receiving the dung, should be done so as to leave a single ridge on the side of the field at which the ploughing commences, that when the land is ploughed for the

seed-furrow, the ridges may be cast together in pairs from one side of the field to the other. If the land still requires draining, the safest mode of feering it will be that for gathering up from the flat, fig. 20, (749.) leaving a half-ridge on the side of the field from whence the ploughing commences, that the ridges may be whole and uniform, from one side of the field to the other, after the seed-furrow has been ploughed.

4171. The dung is then carted out to the fallow field, the dung hawked out, fig. 217, of the carts by each ploughman, in heaps upon each successive ridge, in such quantity to the acre as is determined on. The quantity of dung would be more equally laid down, or rather more discriminatingly laid down, according to the wants of the soil in different parts of the field, where the soil is unequal in heights and hollows, were the steward or other appointed man to hawk it out as the carts came to the field. As bare-fallow land is never so heavily manured as for green crops, from 12 to 15 tons to the acre is sufficient manuring for it. At least four field-workers should divide and spread the dung evenly over the surface of the ground with ordinary graips, fig. 82, and the ploughs follow them quickly in succession from feering to feering, in order to cover in the dung as rapidly as possible from the heat of the sun. It is too common a practice, however, to spread the dung upon bare-fallowed land some time before it is ploughed in.

4172. I much prefer ploughing in the dung in bare-fallowed land in drills. The drills are made in the single way, (2389,) across one corner of the field to the opposite one, at an indefinite angle with the line of the future ridges. The dung is hawked into the drills, spread by four field-workers, and covered in with the ploughs returning from making the drills, very similar to the dunging for potatoes and turnips, (2750.) The dung is thus quickly spread and covered up, and the land remains in the drill until the season for sowing the wheat arrives.

4173. Bare-fallow land is manured in England by confining sheep upon it, within hurdles, fig. 40, or within nets, fig. 44,

and fed with tares or other forage plant, brought to them. As one break of land is sufficiently manured, a new one is enclosed. This practice is called *folding*, and has not as yet been introduced into Scotland.

4174. Another mode of manuring fallow-land, is sowing some kind of rapidly growing plant upon it, and then ploughing it in. White mustard, *Sinapis alba*, is a plant which might be employed in this manner with advantage. About 12 lb. of the seed should be sown on the acre, and after the plant has reached above 4 inches, it should be ploughed in. The cost of this seed is 4d. per lb. This operation is called *green manuring*, and may be practised with many other plants.

4175. It is supposed that light and heat, together with cleansing and working, have a beneficial effect upon soil. That these agencies promote fertility in some way, perhaps by affording facilities to the union of oxygen and carbonic acid with the soil, appears certain, for a smaller quantity of manure will raise as large a crop with bare-fallow as a greater quantity without it; and yet this particular result is only obtained from a peculiar class of soils—namely, the strong clays, as all turnip soils actually become more fertile by the overshadowing of a luxuriant crop of leaves than by exposure in bare-fallowing.

4176. The following observations of Liebig may explain the mutual action referred to of the air and the soil. "In the effects produced by time, particularly in the case of fallow, or that period during which a field remains at rest," he says, "science recognises certain chemical actions, which proceed continuously by means of the influence exercised by the constituents of the atmosphere upon the surface of the soil. By the action of the carbonic acid and oxygen in the air, aided by moisture and by rain-water, the power of dissolving in water is given to certain constituents of rocks, or of their debris, from which arable land is formed; these ingredients, in consequence of their solubility, become separated from the insoluble constituents. . . . The same chemical actions as these proceed in our arable land, and it is to accelerate and increase these that we employ the mechanical operation of culture. We renew the surface of the soil, and endeavour to make every particle of it accessible to the action of carbonic acid and of oxygen. Thus we procure a new provision of soluble mineral substances, which are indispensable for the nourishment and luxuriance of a new generation of plants. . . . Fallow, in its most extended sense, means that period of culture during which a soil is exposed to the action of the weather, for the purpose of enriching it in certain soluble ingredients. In a more confined sense, the time of fallow may be limited to the intervals in the cultivation of cereal plants; for a maga-

zine of soluble silicates and of alkalies is an essential condition to the assistance of such plants. The cultivation of potatoes or of turnips during the interval, will not impair the fertility of the field for the cereals which are to succeed, because the former plants do not require any of the silica necessary for the latter. It follows, from the preceding observations, that the mechanical operations in the field are the simplest and most economical means of rendering accessible to plants the nutritious matters in the soil.*

4177. Numerous weeds lurk about the *margins of fields*, rendering the cultivated ground near them foul. Most farmers allow them to grow without molestation in the ground not touched by the plough, which is the narrow space along the fences, and the triangular space in the four corners of every field. This waste ground being well sheltered, and its soil being as good as that of the field in which it is situate, and unexhausted by cropping, grows weeds easily and luxuriantly. Instead of allowing it to be *waste ground*, the plough should turn over the soil either *towards* the foot of the stone fence-wall, the root of the hedge, or the lip of the ditch, or *from* these objects, and in either case, the distance from them and the plough need not exceed 9 inches, by putting the horses *atrip*,—that is, one before the other in the plough, and giving the bridle of the plough more land. The corners where the plough cannot possibly reach, should be dug with the spade by the hedger. But independent of the consideration of the waste land lessening the extent of every field, the weeds which grow upon it should be cut down by the field-workers in all the fields, whether bearing green or grain crops, at intervals of time during summer and autumn. Besides the slovenliness exhibited in neglecting to weed such places, loss is incurred elsewhere, by allowing the seeds of syngenuous plants to be carried about by the wind. Besides thistles, ragweed, dock, whin, and broom, other weeds are found in those waste places, such as the common burdock, *Arctium lappa*, which is not the least formidable; the hemlock, *Conium maculatum*, a well-known poisonous plant; the purple fox-glove, *Digitalis purpurea*; the annoying dandelion, *Leontodon taraxacum*; and the great nettle, *Urtica dioica*. In damp situations, *En-anthe crocata*, water sap-wort grows; and what is remarkable in this plant, is the fact of its being poisonous in England, but innocuous in Scotland.

4178. The couch-grass, *Triticum repens*, is not despised everywhere, as it is gathered from the land and washed, and sold in the markets of the south of Europe in bundles, of the size a small hay-fork would take up, for 3d. or 4d. each; and the horses and mules of those countries seem to relish it as much as the boys do a stick of liquorice.

4179. As fallowed land is usually manured along the feered ridges, by depositing the loads in heaps, I might here give a table showing the

number of heaps each cart should afford in manuring an acre with a given number of cart-loads; but as *heaps* of manure are an indefinite standard of measure, such a table would practically prove of little service. A much more accurate plan is to number the ridges in an acre in each field, and at every part of a field where the ridges are of different lengths, as I have recommended in (573,) and lay down the dung on the first ridge in the proportion it is proposed to manure the acre, and by the time the second ridge is manured, the man who hawks out the dung will have found out how close the hawkfuls should be laid down, or how large the heaps should be made, (4171.)

4180. Green weed of very delicate texture, "found alone in protected situations in the estuaries of our rivers, is used in the upper parts of the Forth, and still more so in the Eden in Fifeshire. Mr Meldrum of Bloomhill, near St Andrews, besides collecting the weed on his own shore, rents that of his neighbours. He frequently applies from 300 to 400 cart-loads in a single year, and reckons 10 cart-loads good, and 15 heavy manuring. When laid on in winter, and ploughed into the fallow ground, it produces a fine pulverising effect. With this alone a wheat crop of 6 quarters an acre has been produced, with a heavy crop of beans the year after without additional dung."† Such green weed can as well be laid on fallowed ground in summer, as on stubble in winter.

4181. On the varieties of green manures, and of their action on the soil, Professor Johnston has the following observations:—"The practice of green manuring has been in use from very early periods. The second or third crop of *lucerne* was ploughed in by the ancient Romans—as it still is by the modern Italians. In Tuscany, the *white lupin* is ploughed in—in Germany, *borage*—and in Holstein, *spurry*. The *Madia sativa* has lately been tried as a green manure in Silesia. In French Flanders, two crops of *clover* are cut and the third ploughed in." We have seen, from what Mr Fortune has observed, that the *red clover* is grown in China entirely for the purpose of being ploughed in (3898.) "In some parts of the United States, the clover is never cut, but is ploughed in as the only manure; in other parts, the first crop is cut and the second ploughed in. In some of the northern states, Indian corn is sown on poor lands, sometimes two or three times, and turned in during the summer. In north-eastern China, a species of *coronilla* and a *trefoil* are specially sown and grown in ridges, as a manure for the rice crop. . . . Since the time of the Romans, it has been the custom to bury the cuttings of the vine stocks at the roots of the vines themselves; and many vineyards flourish for a succession of years without any other manuring. In the Weald of Kent, the prunings of the hop bine, chopped and dug in, or made into a compost and applied to the roots of the hop, give a larger crop, and with half the manure, than when they are burned or

* Liebig's *Chemistry in its Application to Agriculture*, 3d edition, p. 130-3.

† *Quarterly Journal of Agriculture*, vol. xi. p. 308.

thrown away, as is usually done. Buck-wheat, rye, winter-tares, clover, and rape, are all occasionally sown in this country for the purpose of being ploughed in. This should be done *when the flower has just begun to open*, and, if possible, at a season when the warmth of the air and the dryness of the soil are such as to facilitate decomposition.

4182. "That the soil should be richer in vegetable matter, after this burial of a crop, than it was before the seed of that crop was sown, and should also be otherwise benefited, will be understood by recollecting that perhaps three-fourths of the whole organic matter we bury has been derived from the air—that by this process of ploughing in, the vegetable matter is more equally diffused through the whole soil, than it could ever be by any merely mechanical means—and that by the natural decay of this vegetable matter, ammonia and nitric acid are, to a greater extent, produced in the soil, and its agricultural capabilities in consequence materially increased. Indeed, a green crop ploughed in is believed, by some practical men, to enrich the soil as much as the droppings of cattle from a quantity of green food three times as great.*"

4183. A kind of fallowing, technically, named *rag-fallowing*, is sometimes practised. This consists in pulverising lea ground in summer as a preparation for wheat in autumn. The lea is broken up in August, or as long before harvest as to allow time for the land to be worked ere the commencement of harvest; and as the object is to reduce the turf as much as possible, the first ploughing should be given with a shallow furrow. After the land has become dry, it should be harrowed repeatedly in double times along and across the ridges, in order to tear the furrow-slices to pieces, and to shake the earth from the turf. The turf then should lie some days to dry, when it may be harrowed again, if it is thought that any more earth can be shaken from it. After the turfs are much withered, the land should be cross-ploughed with a deep furrow to bring up a body of mould, which, when dry, should again be harrowed, and many of the turfs will be brought to the surface, still farther to wither and die. The land should then be ploughed in ridges for the seed-furrow, to remain till seed-time after harvest, by which time it will have consolidated and be ready for the seed.

4184. The objection to this operation is, that it sacrifices the pasture after the month of August. But as much wheat is sown in England after lea, and as lea-wheat is very liable to be attacked by the wire-worm, fig. 253, and even partially destroyed by that grievous pest, should this rag-fallowing in any degree effect its destruction, the operation is justifiable. In Scotland, where wheat is not sown after lea, the destruction of good pasture, at an early period of the season, is not justifiable. The expedient of rag-fallowing is adopted to form a consolidated mould for wheat, when it is intended to be sown after

lea; but in attempting the attainment of this end, the opposite error of rendering the soil too loose for wheat is frequently committed; at all events, the crop never looks promising after rag-fallowing, and, in truth, the expedient is never resorted to but by farmers who wish to take advantage of their land.

4185. A species of *spade husbandry* has of late years been recommended in Scotland as a substitute for summer-fallowing; not on a small scale, as suitable to the case of cottiers and small farmers only, but on a large one, fitted for a farm of the largest class. The only farmer I have heard of, who has practised spade-husbandry on a scale commensurate with ordinary farming in Scotland, is Mr Archibald Scott, Southfield, East Lothian. "In 1831," says Mr Scott, "I determined to ascertain the difference of the expense and produce between trenching land with the spade, and summer-fallowing with the plough in the usual way. I therefore trenched 13 acres of my summer-fallow break in the months of June and July. I found the soil about 14 inches deep; and I turned it completely over, whereby putting up a clean fresh soil in the room of the foul and exhausted mould, which I was careful to put at the bottom of the trench; and this operation, I found, cost about £3, 12s. per imperial acre, paying my labourers with 1s. 6d. per day. The rest of the field, consisting of about 11 acres, I wrought with the plough in the usual way, giving it 6 furrows, with the suitable harrowing: I manured the field in August; the trenched got 7 cart-loads per acre, the ploughed land 14. The field was sown in the middle of September, and the whole turned out a bulky crop as to straw, particularly the trenched portion, which was very much lodged. On threshing out both, I found them to stand as under:

By trenched wheat, 42 bushels per acre, at 6s. 9d.	£14 3 5
To 2 years' rent, at 40s. per annum,	£4 0 0
.. expense of trenching,	3 12 0
.. seed, 2½ bushels, at 6s. 9d. per bushel,	0 16 10
.. 7 cart-loads of manure, at 3s. 9d. per load,	1 6 3
.. expense of harvesting, threshing and marketing,	1 4 0
	10 19 1
Profit,	£3 4 4

By ploughed wheat, 34 bushels per acre, at 6s. 9d. per bushel,	£11 9
To 2 years' rent, at 40s. per annum,	£4 0 0
.. 6 ploughings and harrowings, at 8s.,	2 8 0
.. seed, 2½ bushels, at 6s. 9d. per bushel,	0 16 10
.. 14 cart-loads of manure, at 3s. 9d. per load,	2 12
.. expense of harvesting, threshing and marketing,	1 4 0
	11 1 4
Profit,	£0 8 2"

This was but an experimental trial, and the result was certainly an encouragement to perseverance; but it only proved that trenching land with the spade might be a substitute for bare-fallowing, it did not prove that summer-fallowing might be dispensed with, so another experiment

* Johnston's *Elements of Agricultural Chemistry*, 5th edition, p. 160-2.

was worth the trial, to ascertain this important point. Accordingly, Mr Scott "now saw, that though it might be profitable to trench over the fallow-break during the summer months, it was by no means making the most of the system, as the operation was not only more expensive, owing to the land being hard and dry in summer, but that it was a useless waste of time to take a whole year to perform an operation that could as well be done in a few weeks, provided labourers could be had; and as, in all agricultural operations, losing time is losing money; as the rent must be paid whether the land is carrying a crop or not, so that in taking one year to follow the land, and another to grow the crop, two years' rent must be charged against the crop, or at least there must be a rent charged against the rotation of crops for the year the land was fallowed; as I felt satisfied, that, by trenching with the spade, the land would derive all the advantages of a summer-fallowing, and avoid all the disadvantages attending it, I determined on trenching about 40 acres of my fallow-break, immediately on the crop being removed from the ground, and had it sown with wheat by the middle of November 1832, and I did not apply any manure, as I thought the former crop was injured by being too bulky. As the crop is now threshed and disposed of, it stands per acre as follows:—

By average of 40 acres, 36 bushels,		
at 7s. per bushel,		£12 12 0
To rent of land per acre,	£2 0 0	
„ expense of trenching,	3 4 0	
„ seed,	0 16 0	
„ harvesting, threshing,		
and marketing,	1 4 0	
		7 4 0
Profit,		£5 3 0*

This trial was also satisfactory, because it not only proved that trenching with the spade might be substituted for summer-fallowing, but that summer-fallowing might be profitably dispensed with altogether; but it must be owned to be rather sharp practice to make the same depth of soil, although its component parts were not in the same relation to one another, bear one crop immediately after having borne another, and that without manure, and at a period of the rotation when manure is usually given to land. Mr Scott seems satisfied with the system; but it may be asked, How long will land bear this system of trench-fallowing with impunity? "The advantages of trenching over summer-fallow are, in my opinion," says Mr Scott, "very decided, as it is not only cheaper, but, as far as I can yet judge, much more effectual. I am so satisfied of this, not only from the experiments above noticed, but from the apparent condition of the land after it has carried the crop, that I have this autumn cultivated about 120 acres with the spade, and the crops are at present, 1834, very promising. When I first commenced I was laughed at by my neighbours; but now, when they see me persevering in what they considered a very chimerical project, they suspend their

judgment, and several of them have made considerable experiments this year. I should think there are at least 300 acres under crop-cultivation in this way this season in East Lothian, while in 1831, when I commenced, there was not a single acre. I have, therefore, the satisfaction of knowing, that I have been the means of causing £1000 to be spent this year amongst the labouring classes in my immediate neighbourhood; and I feel confident, that should the season turn out favourable for the wheat crop, and fair prices be obtained, their employers will be handsomely remunerated for their outlay. I do not mean to say that this system will succeed on every description of soil, as it must necessarily be of some depth to admit of the operation; but there are few districts where such soil will not be found in sufficient abundance to give employment to the population of the neighbourhood.*" I believe the adoption of this mode of fallowing land was made a question between landlord and tenant, and since the question was decided against the tenant, I have not heard of any instance of the process being persevered in. I should like to see trenching established generally as a substitute for summer-fallowing, and also to see the effect of trenching on land intended for green crops; but in neither case ought the land to be taken advantage of to bear a crop without manure at the ordinary period of the rotation, and it would be better to apply a special manure which would check exuberant growth in the straw, than not to apply manure to the soil.

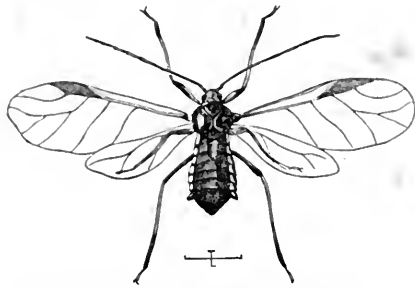
ON THE REAPING OF TURNIP SEED.

4186. While the turnip plant is growing it is subject to several casualties from insects and birds. Of the insects the *Cetonia aurata*, green rosechafer, is found on the flowers, and renders them abortive. It is one of the most beautiful of our insects, having a brilliant metallic green, often with a golden or copper hue. Its length is three quarters of an inch. It is found in numbers in England, but has only been observed one, two, or three times in Scotland. The larva commits a good deal of damage where it prevails, by feeding in the same way as other chafers. The flower of the turnip seed is also infested by one of those universal pests, the aphides. Fig. 360 represents the winged male of the plant-louse, *Aphis floris-rapæ*, which attacks the flowers of the turnip plant, when raised for the seed. It is dull pale green, dusted with white; eyes, head, disc of the thorax and abdomen varied with black; feet black. Fig. 361 represents the wingless

* Mr Scott's Letter to the Rev. C. Gardner, 8th March 1834.

female of the same plant-louse. It is dull pale green, powdered with white; eyes

Fig. 360.



WINGED MALE OF THE TURNIP-FLOWER PLANT-LOUSE—*APHIS FLORIS-RAPEE*.

black; feet black. "Towards the end of July," says Mr Curtis, "I found a multitude of these aphides

Fig. 361.



WINGLESS FEMALE OF THE TURNIP-FLOWER PLANT-LOUSE—*APHIS FLORIS-RAPEE*.

secreted amongst the short flower-stalks of the early white turnip, when a few only of the flowers were open. They were of various sizes, but all apterous at that period; by the middle of August, however, they had increased to very large companies, with a few winged specimens." *

4187. The turnip seed, when growing, is seriously injured by the weevil named *Ceutorhynchus assimilis*, referred to in (3299.) As weevils are so sensitive as to fall down, if suddenly approached, they may be easily collected when they abound in the turnip-flowers left for seed, by shaking the stalks over a bag-net or cloth; and being so hard that they cannot be destroyed by stamping upon them, they must be killed, when collected, with boiling water in a pail.

4188. Long before the seed is ripe, small birds are busy in shelling it out of the husk; and were they to destroy only what they consumed, the loss, perhaps, would not be great; but as they spill a great deal more than they consume, a whole pod is destroyed for the sake of one seed. In this depredation none are so active as

the *Linaria cannabina*, variously denominated grey, brown, or rose linnet, or rose-lintie, one of the sweetest warblers of our woods. There is no way of evading the attacks of these active marauders but by constant watching from dawn to eve; and the watching will be rendered more effectual by alleys being left crossing each other when the bulbs are transplanted, to allow the watchers to pass at pleasure in various directions through the plot. (2479.)

4189. The crop should be cut down with the sickle before it is ripe, as the seed is very apt to shake out; and the best mode of preserving and winning the seed is to place the stems in frames of wood having a hollow along their length, to allow the air to pass along; and the stems placed on it as upright as that their butt-ends shall project over the lower laths of the frame, and above one another, so as to form a sort of thatching of stems. The upper part of the thatching is filled up and rounded with the smaller stems of seed, cut off from the larger, and the whole is covered with straw, and bound down with straw-ropes. When this plan is not adopted, the stems are bound in sheaves, set up in stooks and watched for some days, and then built in a stack, which is thatched with straw bound down with straw ropes. The seed is threshed out by the flail, fig. 350, when wished to be disposed of or used.

4190. A crop of Swedish turnip-seed, when grown from the seed, is considered good when it yields 28 bushels per imperial acre; of yellow turnips, 20 bushels; and of globes, 24 bushels. When transplanted, the yield will perhaps double these quantities.

ON MAKING BUTTER AND CHEESE.

4191. The dairy operations of a farm of mixed husbandry are limited, both in regard to the season in which, and the quantity of materials by which, they can be prosecuted. Until the calves are all weaned, which can scarcely be before the end of June, (3838,) there is no milk to spare to make into butter and cheese, but what should suffice for the inmates of the

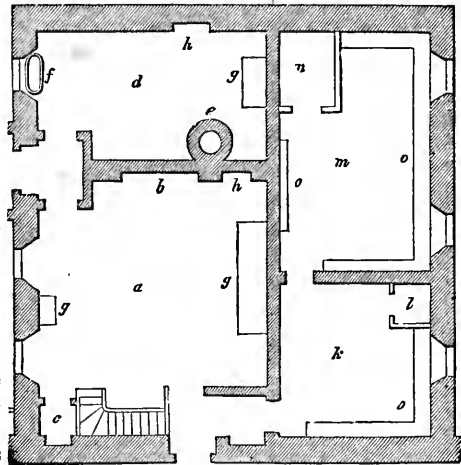
* *Journal of the Agricultural Society of England*, vol. iii. p. 55.

farm-house; and as some of the cows, at least, will have calved 4 months before the remainder are at liberty to yield milk for the dairy, a quantity of milk cannot be expected from them, even when entirely supported on grass. But though thus limited, both in regard to time and milk, ample opportunity is nevertheless afforded for every dairy operation, according to the taste and skill of the dairy-maid. Thus, butter may be made from cream, or from the entire milk. It may be made up fresh for market, or salted in kits for families or dealers. Cheese may also be made from sweet and skimmed milk, for the market; and any variety of fancy cheese may be made at a time, such as cream-cheese, Stilton, Gloucester, North Wilts. With all these means at command, to a moderate extent, it is quite possible for the dairy-maid to display as much skill and taste in her art, on a farm of mixed husbandry, as on a dairy farm; and not only in all these respects, but in the many forms in which milk may be served on the table of the farmer. The only difference in the operations of a dairy farm, from one of mixed husbandry, is, that all its dairy operations are conducted on a much larger scale.

4192. The milk-house and cheese-room in a farm-house ought to be cool and roomy. To obtain the former requisite, they should, if possible, be exposed to the N., from which the air should be of the purest description; but should any obstruction exist against that, the rooms may face to the E., which only admits the sun's rays early in the morning, when they are comparatively weak. Besides being so exposed, to be always kept cool, the rooms should be situated in a back jamb, and not in the body of the house. In fig. 362, I have endeavoured to arrange the milk-house and kitchen pantry, so as to stand conveniently in relation to the kitchen and scullery, where *a* is the kitchen, *d* the back kitchen or scullery, in which are erected a boiler *e*, for heating water to scald the dairy utensils, a force pump to supply cold water, and *f* a sink to remove the dirty water; *k*, the kitchen pantry, disconnected from the kitchen by a passage and door; *m*, the milk-house, having two windows facing to the N. or E.; a lock-up closet *n*; shelving *o*, of stone around; and the dimensions 18½ feet in length, 12 feet in

breadth, and 10 feet in height, with the walls and ceiling lathed and plastered, to

Fig. 362.

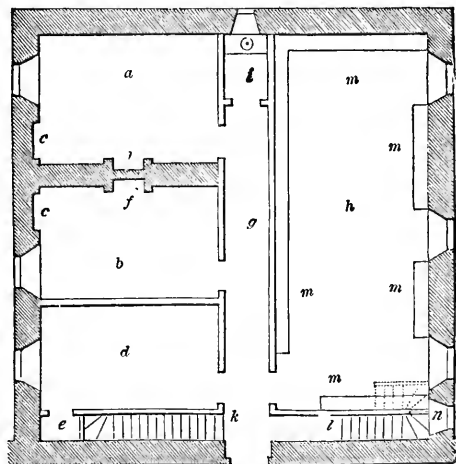


GROUND PLAN OF A MILK-HOUSE IN RELATION TO THE KITCHEN, IN A FARM-HOUSE.

keep the room cool and free of damp, that no mouldiness be generated—the bane of a milk-house, certain to contaminate the flavour of milk; and the floor laid with polished pavement, in order to allow it to be easily and quickly washed clean, and as quickly dried.

4193. Fig. 363 is the plan of the cheese-room, situated immediately above the milk-house and kitchen-pantry in fig. 362, and in which *k* is the stair from the

Fig. 363.



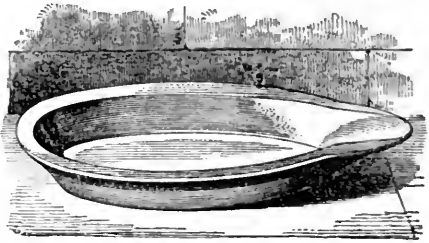
PLAN OF CHEESE-ROOM, &C., FOR A FARM-HOUSE.

kitchen to the passage *g*, from which the cheese-room *h* is entered. This room is provided with three windows, facing either N. or E., with broad wood shelving *m*, all round, for the accommodation of the cheeses in their various stages to maturity, in which the wood-flooring should be made to assist. The walls and ceiling should be lathed and plastered. The lower halves of the windows should be provided with Venetian shutters outside of the glass-sashes, to regulate the air into the room when the windows are opened. This cheese-room is 29 feet in length, 12 feet in width, and 9 feet in height. The letter *l* indicates a stair to a garret above, for containing lumber; but should it be desired to give a loftier height than 9 feet to the ceiling, the part of the garret above the cheese-room might be dispensed with, and a lathed and plastered ceiling carried up to the roof of the house.

4194. The *utensils* with which a dairy should be supplied comprise a large number of articles of simple construction. The *milk-dishes* are composed of stoneware, glass, wood, metal, and stone. The stoneware consists of common ware and Wedgewood; the wooden of cooper-work; the metal of block-tin and of zinc; the stone of sandstone, pavement, and marble polished. Besides these simple elements, a combination of materials are used, as, wooden vessels lined with block-tin and zinc, and German cast-iron lined with porcelain. Of all these, the stone and wooden ones lined with metal are stationary, and the others movable. The form of all milk-dishes should be broad and shallow, for the purpose of exposing a large surface with a shallow depth of milk, to facilitate the disengagement of its several parts. A difference in opinion exists, which of those substances have the greatest influence in disengaging the largest quantity of cream from the milk. But, independently of the quantity of cream, other circumstances determine the choice of milk-dishes. Wooden ones require much labour to keep them thoroughly clean, and are the least liable to be injured in the use. Metal ones also require much cleansing, and are liable to be bruised. Stoneware is easily frangible, though very easily cleansed. Glass is as easily cleansed, and perhaps more frangible.

4195. Common stoneware milk-dishes are brown outside and glazed yellow inside, of round form, tapering to the bottom, and without a mouth to pour the milk by. When 15 inches in diameter, and 4 inches deep, inside measure, they cost 9d. each. They are easily cleaned and broken, and the glazing is not durable.

4196. Fig. 364 represents a milk-dish
Fig. 364.



WEDGEWOOD-WARE MILK-DISH.

of white Wedgewood ware, of an oval form, 16 inches long, and 3 inches deep, inside measure, with a mouth. This ware is hard, not easily broken, the glazing durable, and easily cleaned. A dish of this size costs 6s. Wedgewood, or white ware, is also made of the form of the wooden one of cooper-work, fig. 366, with the addition of two handles to lift the vessel by.

4197. Fig. 365 represents a milk-dish
Fig. 365.

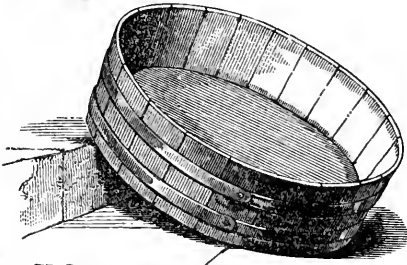


GREEN GLASS MILK-DISH.

made of light green-coloured glass, of a circular form, 16 inches in diameter, and 4 inches deep, and with a mouth. It is easily cleaned, and easily broken, if carelessly handled. The cost of a dish of this size is 4s. 6d. Glass milk-dishes were first introduced to public notice a few years ago, by the celebrated glass manufacturer, Mr Pellat, of London, and are now manufactured by various makers.

4198. Fig. 366 represents the common wooden milk-dish, made of cooper-work,

Fig. 366.

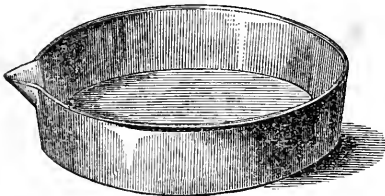


WOODEN MILK-DISH.

composed of staves of oak and flat hoops of iron, and without a mouth. It is made 16 inches in diameter, and 4 inches deep, inside measure; and costs 2s. each. This is the most durable of milk-dishes, though it requires much scrubbing when in use to keep it clean, and the iron hoops bright, which they should always be.

4199. Fig. 367 represents a milk-dish made of zinc, of a circular form, 18 inches

Fig. 367.



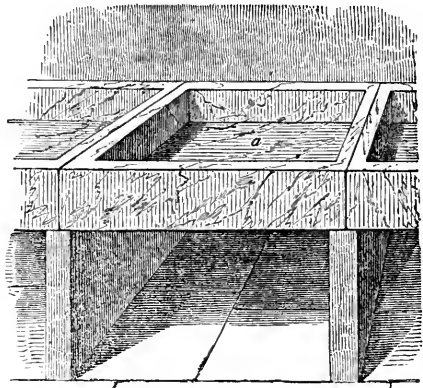
ZINC MILK-DISH.

in diameter, and 3 inches deep, provided with a mouth, and costs, of this size, 2s. each, the price varying 3d., more or less, for every inch in the diameter. It requires much cleansing, and is apt to be bruised, though not easily broken.

4200. These are all movable dishes: a fixed one is represented by fig. 368, made of stone—sandstone, slate, or marble—the last being the best material, being cool, cleanly, and handsome. An orifice is made in the bottom, at the near side, through which the milk runs out of the cooler, as also the water which has been used to wash it clean. The dimensions may be made at pleasure, 3 feet long and 2 feet broad being a good size; but the depth should not exceed 4 inches, to con-

tain from 2 to 3 inches of milk. When made of wood lined with zinc, block-tin,

Fig. 368.



A FIXED MILK-COOLER OF MARBLE, OR OF WOOD LINED WITH METAL.

tin, or lead, the form is the same as this. The sandstone and marble ones, as α , fig. 368, are each hewn out of single blocks and polished, and placed upon upright slabs; and the wooden ones, which support the metallic lining, are framed along the walls of the milk-house, and subdivided into separate coolers. It is only in large dairies that these fixed coolers are used.

4201. Dr Taylor has these observations in regard to the use of vessels made of zinc for dairy purposes:—"Zinc has been lately used in making utensils for holding milk during the separation of cream. It is probable that some of the lactate of zinc is here formed, as well as a combination of the oxide of zinc with casein. I have been informed that milk and cream, which were allowed to stand in such vessels, have given rise to nausea and vomiting. This practice would not be allowed under a proper system of medical police. When an acid liquid has been placed in a zinc vessel, there is a strong chemical action, and the liquid becomes invariably impregnated with a salt of zinc. A cider merchant kept for three months a quantity of cider in vessels made of zinc. It was observed that the liquid had then acquired an acid and styptic taste. On analysis, it was found to contain a large quantity of acetate of zinc. It had, therefore, become decidedly poisonous." Milk kept in zinc vessels until it becomes sour, would, I have

no doubt, produce a similar poison. When milk is so delicate a fluid, and so easily affected by any deleterious substances, great caution ought to be practised in using any metallic vessels in the dairy which might possibly injure its quality.

4202. Besides the substance of the vessels containing milk causing it injury by direct action, milk is affected by the poisons taken by animals, being absorbed into their lacteal system. "It is generally admitted that milk may become poisoned when the cow feeds upon *hysop*, *Gratiola officinalis*, and spurge, *Euphorbium pepus*, and other irritant vegetables; and this form of poisoning is well known to occur in other cases in which the cause is not so apparent. A patient was advised by his medical attendant to drink the milk of a cow fed on hemlock, *Conium maculatum*. The animal became emaciated, lost its milk, and, fortunately for the patient, died from the effects of the poison, or it is not improbable that he might have fallen a victim to this plan of treatment. Milk also easily undergoes changes according to the food of the animal. It is rendered bitter when the cow feeds on worm-wood, *Artemesia absinthium*; on sow-thistle, *Sonchus alpinus*; the leaves of the artichoke, *Cynara scolymus*; and its taste is affected by the cabbage, carrot, and all strong smelling plants, and the effects extend to butter, cheese, and all articles of food prepared with milk."

4203. But all the effects of poisoning may be produced by milk without the cow being apparently affected by the pasture. "In some extensive districts of North America, to the west of the Alleghanies, the herbage has no injurious effect upon the animals which are there pastured, but their milk and flesh, when used as food, are poisonous to man. The disease produced by the use of the flesh and milk of animals fed in those districts, is known under the name of milk-sickness or *trembles*. On account of the prevalence of this malady in a particular locality, which is generally strictly circumscribed, the early emigrants were often compelled to seek another; and those who now venture within the boundaries of an infected dis-

trict are constrained, as a condition of their residence, to abstain from the flesh of the cattle living within the same limits, as well as from the milk and its preparations. The inhabitants, with a recklessness of human life which seems incredible, carry the butter and cheese which they themselves dare not eat, to the markets of the towns west of the Alleghanies, and thus there are frequently produced symptoms of poisoning, and even death, for which the medical attendant cannot account. It is also stated that the cattle from these districts are sent for sale in great droves over the mountains; but, in order to deceive the buyers as to the place whence they come, they bring them to New York by a southern route, and style them 'southern cattle.' The flesh of these animals produces, in those who make use of it, symptoms of aggravated cholera morbus. The viscera of the animals are often found diseased, and the livers almost universally so. Owing to the symptoms which have followed the use of the beef and cheese thus poisoned, the American government caused a medical inquiry to be instituted into the matter, with a view to prohibit the sale."

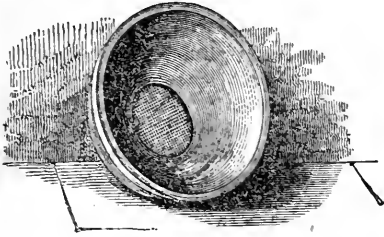
4204. But farther still, the milk of the mother may become a medium for the transmission of poison. "Two ewes were bitten by a rabid dog. Rabies appeared in them about six weeks after the bite, and they were killed. One had two lambs, the other one. At first they were permitted to suckle. The lambs were subsequently attacked with rabies, and were then killed. It appears highly probable that they received the poison through the milk, because they were removed from the ewes a month before these became affected; there was no mark of their having been bitten, nor is it proved that a sheep can communicate the poison by a bite, either before or after it has been attacked with rabies."*

4205. Another utensil required for the use of the milk is a milk sieve, fig. 369, which consists of a bowl of wood formed of plane-tree, having an orifice in the bottom, which is covered with wire gauze, in order to detain the hairs, on letting the milk pass through it, that may have fallen into the milking-pails from the cows in the act

* Taylor *On Poisons*, p. 499, 561, 563, and 823.

of being milked, (2245.) The gauze is commonly made of brass-wire, and, when

Fig. 369.

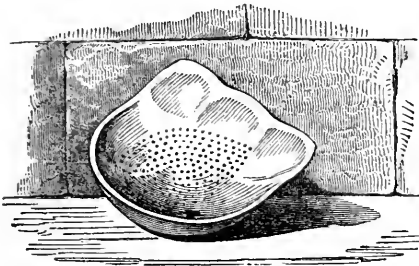


THE MILK-SIEVE.

kept bright, answers the purpose; but silver wire is much less likely to become corroded by use. Such a sieve, 9 inches in diameter, with brass wire gauze, costs 1s. 3d.

4206. The creaming dish, fig. 370, made

Fig. 370.



THE CREAM-SKIMMER.

of stoneware, is called the skimmer or creamer, for taking the cream off the milk. It is thin, circular, broad and shallow, having on the near side a smooth edge to pass easily between the cream and the milk, and at the upper side, an indentation for the thumb of the right hand to rest in, and a mouth on the right side to pour out the cream by into any vessel. At the bottom are a number of small holes to allow the milk to pass through and leave the cream pure and thick in the skimmer. Such a skimmer costs 1s.

4207. The cream, until it is churned, is kept in a jar of stoneware, as in fig. 371, about 18 inches in height, and 10 inches in diameter, provided with a movable top, having an opening in its centre, covered

with muslin to keep out dust and let in air. Such a jar costs 8s. to 10s.

Fig. 371.



THE CREAM-JAR.

4208. Unless the milk-house is kept *thoroughly* clean, in its walls, floors, and shelves, the milk will soon become tainted; and, to keep them clean, the floors and shelves should be made of materials easily and quickly cleansed. Shelving is mostly made of wood, and flooring of pavement or brick. Wooden shelves are easily cleaned, but are too warm in summer. Stone ones are better, but must be *polished*, otherwise they cannot be cleaned, without being rubbed with sandstone. Marble shelving is the best for coolness and cleanliness, and is not very expensive. Polished pavement makes a more durable, easier cleaned, and cooler floor than brick. Ample means of ventilation are required in a dairy; the object, however, not being so much a constant change or a larger quantity of air, as an equality of temperature throughout summer and winter. To obtain this, the windows, which face N. or E., should not be opened when the temperature of the air is above or below the proper one, which may be stated at 50° Fahrenheit, and to ascertain which a thermometer ought always to be suspended within the milk-house. The milk-house should be thoroughly *dry*; the least dampness in the walls and floor will emanate a heavy fungus-like odour, very detrimental to the flavour of milk and its preparations. All the utensils should be kept thoroughly clean, and exposed to and dried in the open air. Some dairymaids are so careless in this respect, that I have seen seams of green and yellow rancid butter lurking in the corners and angles of churns, and a heavy smell of dirty woollen rags emanating from the newly washed wooden utensils.

However effectual woollen scrubbers may be in removing the greasiness of milk and butter on wooden articles, they should never be employed in a dairy, and only coarse linens, which should be washed clean in hot water without soap, and dried in the air. All the vessels should be quickly dried with linen cloths, that no feeling of clamminess be left on them, and then exposed to the air. In washing stoneware dishes, they should not be dried at that time, but set past singly to drip and dry; and rubbed bright with a dry linen cloth when about to be used. If dried and set into one another, after being washed, they will become clammy. The great objection to using stone milk-coolers is the difficulty of drying them thoroughly before being again used, an objection which does not apply to marble. No milk-house should be so situated as to admit the steam arising from the boiler, which supplies hot water for washing the various utensils; nor should the ground before its windows contain receptacles for filth and dust, but be laid out in grass, with a few evergreens. It is said that the odour of the blossom of the common elder, *Sambucus nigra*, keeps off flies in summer; but I have also heard it stated, that the same powerful odour affects the taste of the milk.

4209. *Milk*.—The articles which engage the dairymaid's attention within the dairy are milk, butter, and cheese; and, first, as to milk. On treating the milking of cows, I have said that the milk is drawn from the cow into a pail (2245,) the most convenient form of which is given in fig. 197, and the size may suit the pleasure of the dairymaid. The milk, on being drawn from the cows, is put into a tub, and left to cool; but not to become so cold or stand so long as to separate the cream. The tub should be placed in the air, and out of reach of animals, such as cats and dogs. After it has cooled, the milk is passed through the milk-sieve, fig. 369, into the milk-dishes, and as much only is put into each dish as not to exceed 2 inches in depth. To know at once the age of milk in the dishes, one mark or score should be made with chalk on the dishes just filled, to show that they contain the last drawn milk; a second mark is made, at the same time, on the dishes containing

the milking before this; and a third put on the dishes containing the milk drawn before the second milking, and which contain the third milking, or oldest milk. If the cows are milked three times a-day, when the first mark is put on the dishes of the evening milking, those containing the morning milking of the same day will have 3 marks, to indicate that the milk was from the third milking previous, and the dishes of the mid-day or second milking will have 2 marks. At every milking every utensil used should be thoroughly cleaned, and set past dry, ready for use when required.

4210. It is always satisfactory to know the quantity of milk obtained from each milking of the cows. When the number of cows is large, it may be troublesome to measure all the milk with a small measure, such as a quart; and when much trouble is imposed on the dairymaid, the probability is that the ascertaining of the quantity will be regarded a trifling matter, and the quantity will be guessed. A rapid way of ascertaining the quantity in any commonly used vessel, is to have a stick with marks upon it, each indicative of a quart, in the depth of the vessel used. When the vessel is a tub, the contents may thus be very easily ascertained by gauging it with the stick, and a stick may also be made to gauge the contents in quart of any irregularly shaped vessel, by having the marks on it placed nearer or farther asunder, according to the form of the vessel.

4211. The next business of the dairymaid, as regards the milk, is to take the *cream* off it. In ordinary weather in summer, the cream should not be allowed to remain longer on the milk than 3 milkings; that is, when a fresh milking is brought in, the cream should be taken off the dishes which already have 3 marks, when the milk will be 20 or 22 hours old. But should the weather be unusually warm, the milk should not be allowed to be more than 18 hours old—that is, in the dishes having 2 marks—before the cream is taken off it. As an example of ordinary routine, the cream of the previous mid-day's milk should be taken off in the morning, and at mid-day the milk of the previous evening should be creamed, and

so on; but when the weather proves very warm, the creaming should be anticipated by one meal, and taken off the two oldest meals at one time; and in this way all the cream that can be got is taken off every 18 hours. The reason for using this anticipation in taking off the cream is, that the milk should on no account be allowed to turn sour before the cream is taken off, because the cream off sour milk always makes bad butter. Let sweet cream become ever so sour after having been taken off sweet milk, and no harm will accrue to the butter. Not that sour cream off sour milk is useless, or really deleterious, as it may be eaten with relish by itself, as a dessert, or with oatmeal porridge. The cream is skimmed off milk with the skimmer or creamer, fig. 370. There is no other way of taking cream off dishes but with a skimmer; but in stationary coolers of metal or of stone, a spigot is drawn half out from a hole in the bottom, on the near side, through which the milk runs slowly into a vessel below, and leaves the cream on the bottom of the cooler—and this manner of separating the cream from the milk is quite effectual; but, of course, the skimmer may be used for creaming the milk in coolers, as well as in dishes. The cream when taken off the milk is put into the *cream jar*, fig. 371, in which it accumulates until churned into butter. Every time a new portion of cream is put into the jar, its entire contents should be stirred, in order to mix the different portions of cream into a uniform mass. The stirring is usually done with a stick kept for the purpose, but spoons of Wedgewood ware or of wood, or of bone, are made for doing it. The cream soon becomes sour in the jar, and it should not be kept too long, as it is apt to contract a bitter taste. Twice a-week the contents of the jar should be made into butter, however little the quantity may be at a time. The skimmed milk is put into a tub and made into cheese; but if a cheese is only made at every other churning, the skimmed milk to be kept for the cheese should be scalded on the fire before it is put into the tub.

4212. *Churns*.—The various forms of churns may be classed under four kinds:—Those in which both the fluid and the containing vessel, with its agitators, are in rotative motion; those in which the

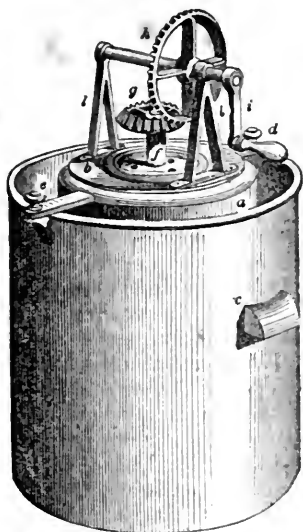
containing vessel is at rest, and the agitators in rotative motion horizontally; those in which the containing vessel is at rest, and the agitators in rotative motion vertically; and those wherein the containing vessel is at rest, and the agitator having a rectilineal vertical motion.

4213. Of the varieties of churns, it is only necessary to mention those in most common use. The old-fashioned upright plunge churn, belonging to the fourth of the classes mentioned above, when worked by the hand, is now chiefly confined to the use of small farmers and cottars; but when inanimate power is employed to move it, it is used by many extensive dairy farmers. The barrel-churn, which belongs to the first class referred to above, and which was so much in vogue upwards of twenty years ago, is now disused. It has been superseded by the box-churn, whose agitators move vertically, and which belongs to the third class mentioned above. One seldom sees the box-churn with horizontal agitators, which belongs to the second class referred to above—and it may be concluded that it is not convenient for use by the hand; and when used at all, it is so in town-dairies, where it is driven by power.

4214. *Table-churn*.—In the class just mentioned stands the table-churn, remarkable for its elegance and cleanliness; and, being adapted for the lighter purposes of the butter-dairy, I have considered it as deserving a place here. This utensil is represented in fig. 372, in perspective, in the most improved form, with outer case to contain hot or cold water. The chief part of this utensil is the Wedgewood receptacle *a*, formed of the finest and strongest white glazed ware of that manufacture: they are of various sizes, from 1 to 4 gallons capacity; it is furnished with a varnished wooden cover *b*. The outer case *c* is made of sheet zinc or of tin plate: it is 2 inches wider than the churn, furnished with handles *c*, and two ears to which the iron cross-bar *e* is attached by two thumb-screws *e* and *d*, serving to secure the cover to the top of the vessel. A brass socket *f* is fixed in the cover, and an iron spindle, armed with three vanes, is fitted to turn in the socket; a wooden pulley is usually placed in the position of the wheel *g* on the top of the

spindle, and, when secured there, it holds the spindle and cover in constant connection.

Fig. 372.



THE WEDGWOOD TABLE-CHURN.

tion. The common drill-bow is the usual medium of power, the string of which being held in tension by the elasticity of the steel-back or bow, any movement backward or forward of the instrument will cause the pulley and spindle to revolve, and the movements are effected by applying the hand to the handle of the drill-bow. When the cover and spindle have been secured by the screws *e d*, and the bow-string applied as above, which is effected by bending the bow until the string is sufficiently relaxed to allow of its being laid once round the pulley, the bow is then allowed to expand, and the operation proceeds. The drill-bow motion is admirably adapted to reversing the motion of the pulley; for, in pushing the bow forward by the hand, the agitator will be made to revolve 2 or 3 times, the number being in the proportion of the length of the string to the circumference of the pulley; and in drawing them back the same number of revolutions will be performed in the opposite direction, and so on till the process is completed. Fig. 373 is a view of the agitator: *a a a* are the vanes of strong tin-plates with perforations, *b* is that part of the spindle that turns within the socket, and *c* that on which the pulley is fastened. The drill-

bow being rather an awkward medium of power, especially in non-mechanical hands, an attempt has been made to substitute for it, the common winch-handle turning vertically. This arrangement is exhibited in fig. 372, where *h* is a tooth-bevelled wheel, on the axle of which the handle *i* is fixed; and it works into the bevelled wheel *g* fixed on the top of the agitator spindle *f*, in the place formerly occupied by the pulley; the two standards *l l* being fixed on the cover *b*, to carry the axle of the wheel *h*. By this arrangement, two turns of the handle *i* produces the same result in the agitator as was done by one stroke of the bow; and the motion of the handle being reversed at every second revolution, the ultimate effect is the same as before, and the manual operation is more easily effected in the one case than in the other. On being used, all the parts of the churn should be taken asunder and cleansed.

Fig. 373.



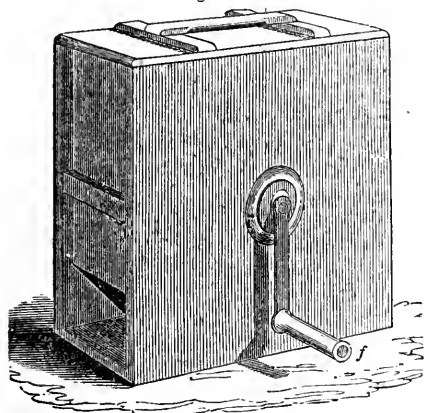
THE AGITATOR.

4215. It is well known that a certain elevation of temperature is acquired by the fluid in the process of butter-making, and that the process is accelerated by producing this temperature artificially, from the application of heated water. For this purpose water is applied externally to the vessels containing the milk and cream, and not in mixture with them. Fig. 372 exhibits the application of this process to the utensil now under consideration, where *c* is the water-case formed of tin-plate, zinc, or of wood, at the bottom of which is fixed a circular stand to place the receptacle *a* upon, that the water may be under as well as around the receptacle. Wood, from its non-conducting quality, is perhaps better adapted than any metal for a water-case. Water brought to the proper temperature is poured into the space between the case and the retaining vessel, and if found necessary to increase or diminish the temperature, part of the contained water is drawn off below by a spigot, and hot or cold added to restore the requisite degree of heat. Experience seems to point out, that, in operating on the large

scale in wooden vessels, no extraneous heat is required, the naturally acquired heat appears to be sufficient; especially if aided in winter by the admixture of a small quantity of moderately heated water, and the non-conducting quality of the wooden vessel retains it; whereas the stoneware vessel will be continually abstracting heat, and giving it off by radiation, if not surrounded by a medium of equal temperature.

4216. *Box hand-churn*.—Fig. 374 represents one 18 inches in length, 11 inches

Fig. 374.

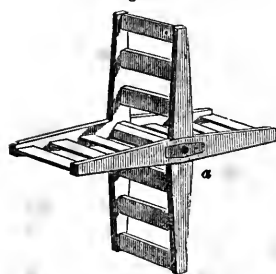


THE BOX HAND-CHURN.

sufficient surface to produce the requisite degree of agitation in the fluid. The two pairs of arms are half-lapped at the centre, and the cross-bars mortised into them; the dimensions in length and breadth being such as to allow it to move with freedom within the box. At the centre, a perforation is made through the sides to admit the iron spindle, which, at this part, is a square bar, fitting neatly into socket-plates of iron let into the agitator on each side, as seen in the figure at *a*. The winch-handle, fig. 375, is shipped, when in work, on the near end of the spindle upon a square stud. In rigging this apparatus, the agitator is placed within the box, and the spindle is pushed through the outer bush and the agitator, until its two journals rest in the bushes; a coupling-ring is then screwed on to the outer bush, until the spindle with the agitator just turns round with freedom in the bushes. To prevent the ring from turning round by the motion of the spindle, a smooth ring or washer of steel may be interposed between the collar and the brass ring. Various other modes of securing the spindle are employed, but in all the object is to prevent leakage at the bush. To prevent taint from galvanic influence, also, it is not uncommon to apply bone or other animal substance for the bushes. This form of churn may be enlarged to any dimensions to suit hand labour or power; and the only modification I have seen of its construction, when on a large scale, is the insertion of the bars of one of the pairs of arms along instead of across the arms.

in width, and 20 inches in depth, inside measure. Birch or plane-tree are the best materials for the purpose, and it requires to be very carefully joined so as to be water-tight. It is of very small moment whether the bottom is formed to the circle of the agitator, or remains flat in as far as the production of butter is to be considered; but for the process of cleansing, the curved bottom will present some advantages. A cover of the same material is fitted

Fig. 375.



THE AGITATOR OF THE BOX HAND-CHURN.

close in the top of the box, with convenient handles. The agitator, fig. 375, is of the usual form: the dimensions of its parts are unimportant, except that they have sufficient strength, and present

4217. *Butter*.—On converting cream into *butter*, the first act is to put the churn into a proper state. It is assumed that the churn, when last used, was put aside in a thoroughly clean and dry state. This being the case, a little hot water, about 2 quarts, should be poured into it to scald and rinse it. In summer it should be rinsed with cold water after the hot, but not in winter. Some people sprinkle a little salt in the churn before the cream is put into it; but whether it does any good or not I cannot say. The churn being thus prepared, the cream is strained into it through a bag of coarse linen cloth, well known under the name of cheese-cloth. This cloth is always washed without soap, and kept sweet by exposure

to the air. It is dipped in water, and then held over the churn; and on the cream being slowly poured into it from the jar, the liquid part will run through into the churn: but the clotted part—which will contain in it dust, drowned flies, moths, and other impurities, which it is impossible to keep out of a cream-jar, which is opened every day—the cloth will keep back, on being gently pressed. The temperature at which *cream* is put into the churn has a considerable influence on the time which the butter will take to make, and also on the weight of butter obtained from a given quantity of cream. It has been found that 55° Fahrenheit is the temperature which best attains these ends; and it is one easily attained in a cool apartment early of a summer's morning. The churning should be done slowly at first, until the cream has been completely broken—that is, rendered a uniform mass, when it becomes thinner, and the churning is felt to be easier. During the breaking of the cream, a good deal of gas is evolved, which escapes from under the cover. When the motion of churning is rotatory, in a large churn, it is continued in the same direction, and not changed backward and forward. I am not sure that a satisfactory reason can be given for making the motion uniform, except that the agitation is sufficient for the making of butter; but the opinion is, that the entire butter is formed more simultaneously; and that the backward and forward motions make the butter soft. In the table churn described above in fig. 372, the motion is reversed, because the cream would not be sufficiently agitated in a churn of cylindrical form, the cream acquiring the motion and velocity of the vanes of the agitator. After the cream has been broken, the motion may be a little increased, and continued until a change is heard in the sound within the churn, from a low smooth to a harsh tone, and until an unequal resistance is felt to be given to the agitators. The butter may soon be expected to form after this, and, by increasing the motion a little more, it will form the sooner; and, the moment it becomes firm and the agitators are felt to be impeded, the motion should cease. The rates of motion in churning butter at different times are of some importance, for, when performed too slow, a longer time is spent in churning

than is necessary, and the butter will be strong tasted; and, when the motion is too rapid, the butter will be soft and frothy, and is said to have *burst*. In very warm weather, or when the cream is put in too warm, that is, much above 55° Fahrenheit, the churning is liable to burst with any degree of fast motion, and then the judgment is specially required to regulate the motion. I suppose that the most proper motion in churning, at the respective periods of the changes undergoing in the cream, has never been ascertained by experiment, but to determine which, though tedious, would be important. When butter forms from cream in churning three quarters to one hour, it is satisfactory work; when it comes much sooner it is soft, and when much later it is strong-tasted. The temperature of the cream by agitation, during churning, rises 3° or 4°.

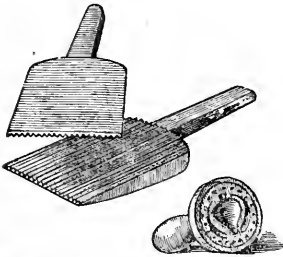
4218. The utensils required for the use of butter are—a small tub for putting the butter in from the churn; a wooden flat shallow kit of the form of fig. 366, and 20 inches diameter, to wash the butter in; scales and weights for weighing the butter before being made up in pounds and half-pounds; a stoneware jar for keeping salt dry; stoneware jars or wooden firkins for packing salted butter in; moulds for stamping prints on butter made up for the table or market; and covered dishes of glass or stoneware, for holding fresh butter in pounds and half-pounds.

4219. Immediately on being formed, butter should be taken out of the churn, and put into the small tub for the purpose. Cold water is then put into the flat kit, which is set in an inclined position, and the butter is washed by being kneaded out and rolled up several times on the bottom of the kit, amongst the water; and then lumps of it are taken in hand, and beaten with the palms of the hand alternately, in order to deprive it of every particle of the butter-milk, the least portion of which would soon render it rancid. The milky water is poured off and fresh poured in, and the butter is again washed and worked as often as the water becomes milky. If intended to be kept or disposed of in a fresh state, the washed lump is divided into pound or half-pound lumps each, weighed in the scales, and placed in sepa-

rate lumps in the tub amongst water. Each of these lumps is then clapped firmly by the hand, and moulded into the usual form in which pounds and half-pounds of butter are disposed of in the part of the country in which your farm is situate. When sold in whole pounds the form is usually cylindrical, of about 8 inches in length; and when in half-pounds in round flat prints bearing a device, such as a rose, a thistle, a stag, a swan, or the name of the dairy. For the table, any requisite number of the pounds should now be moulded from the lump into small prints bearing different devices, or rolled into different forms of balls and cylinders, with small wooden hands, figured on the face. This made-up butter is floated in jars with covers, in a clear strong brine of salt and water, made as strong as to float an egg.

4220. Fig. 376, represents a stamp $1\frac{1}{2}$ inch diameter, for small prints of butter used at table; as also a couple of hands,

Fig. 376.



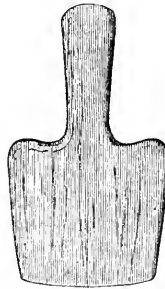
THE BUTTER PRINT-MOULD AND HANDS.

6 inches long and 4 inches broad in the face, and 4 inches long in the handles.

4221. Objections have been urged against the use of the hand in making up butter, and small wooden spades recommended to be employed for the purpose; and the use of water has also been objected to, as it is said to deprive the butter of its pleasing aroma. A woman who has hot clammy hands should never be a dairymaid, as butter is very susceptible of taint, and its flavour will doubtless be injured by the heavy smell of sweaty hands; but naturally cool hands—made clean by washing in warm water and oatmeal, *not soap*, and then rinsed and steeped in cold water, will make up butter freer of butter-milk, and more solid than any instrument

whether of wood or of any other material. As to cold water injuring butter, there being no affinity between fatty matter and cold water, the latter cannot dissolve any essential ingredient out of the former; at any rate, water will more effectually unite with, and thereby take away the milky substance from butter than any instrument manipulated dryly with all the art the hand alone can use. Let the trial be made both ways, and their comparative efficacy tested by the butter keeping longest *sweet*. But less handling may be given to butter with the partial use of the spade, which may be employed in the first process of the washing, by dividing and rubbing, and rolling it amongst the water on the bottom of the flat tub, before it is beaten with the hands; and it is this process which expels the remnants of the butter-milk which cannot be farther reached by the water, and which, if left, would spoil the taste of the butter in a very few days. Fig. 377 represents a

Fig. 377.



THE BUTTER-SPADE.

butter spade of a shape long used in a dairy, the face being 4 inches square, and the handle 4 inches long. The lower side of the face is thinned away to a sharp edge. That such a spade may last in use, and not warp, being thin, it should be made of hard wood, and that of the apple-tree is found to be the most tenacious. The Dutch use an implement for washing butter without the immediate contact of the hand, which is much more effective than this spade. It consists of a board of wood about one foot in length and 4 inches in breadth, grooved longitudinally. Another board, of similar construction and dimensions, is hinged upon one end of the former, and terminates in a handle, which is held by the hand of the dairymaid. The instrument is placed in a flat kit, with water. While the butter is placed by one hand at quick intervals of time, with such a spade as fig. 377, upon the lower board, placed in the water in the vessel, the other hand moves the upper board up and down in repeated action upon the butter, which is alternately and successively divided by

the grooves passing between each other, and kneaded thin by the frequent contact of the area of the boards. By repeated operations in this manner the butter is considered to be freed entirely of the butter-milk. Still the most expert manager of this process cannot free the butter of butter-milk so completely as the manipulation of a pair of cool active hands.

4222. Butter assumes a *texture* according as it has been treated. When burst in the churning, it is not only soft but frothy, and, on being cut with a knife, sticks to it, and seems as if it could be compressed into much smaller bulk. When churned too rapidly, particularly in warm weather, the butter may not be agitated to the state of bursting, but it will continue soft, and never become firm, though worked up with ever so much care, and in the coolest manner; and when a lump is drawn asunder in two pieces, they each present a jagged surface, and also stick to the knife that cuts it. Butter, in either of those states of softness, will not keep long, whether salted or fresh. When over-churned—that is, when the churning has been continued after the butter has been formed—the butter becomes soft, not unlike the state when it is too rapidly churned. When properly churned, both in regard to time and temperature, butter becomes firm with very little working, and is tenacious; but its most desirable state is that of waxy, when it is easily moulded into any shape, and may be drawn out a considerable length before breaking. It is only in this state that butter possesses that rich nutty flavour and smell, which impart so high a degree of pleasure in eating it, and which enhance its value manifold. It is not necessary to taste butter on judging of it; the smooth unctuous feel, on rubbing a little between the finger and thumb, expresses at once its richness of quality; the nutty smell indicates a similar taste; and the bright, glistening, cream-coloured surface, shows its high state of cleanliness.

4223. What I have stated in reference to the making of butter, applies particularly to that obtained from cream alone, and from cream in the usual state for butter—namely, after it has become sour by keeping; but butter can be obtained

from sweet cream, though churning renders its butter-milk as sour as that from sour cream. To have butter in perfection from sweet cream, it should be churned every day; and as a daily supply of cream must be small, a small churn must be used, to have butter fresh made every day. The table-churn, fig. 372, becomes useful for this purpose. I see it alleged, in advertisements of table-churns, that butter may be made in them from cream in 10 or 12 minutes. I have made several experiments with such a table-churn, in churning cream at different temperatures, and with different velocities, but never obtained good butter in less than 30 minutes; and when formed so quickly as in 15 minutes, the butter was soft and frothy. I have heard it alleged that butter of the finest quality cannot be obtained from sweet cream; but I know from experience that butter of the richest quality, flavour, and appearance, can be made from sweet cream. Were such butter not superexcellent, would noblemen have it on their tables every morning? I consider butter out of the churn, and before it is washed, most delicious. It is true that sweet cream requires longer churning than sour; still butter is obtained from it in from 30 to 40 minutes. For my own use, I would never desire better butter, all the year round, than that churned every morning in a small churn from sweet cream. Such butter, on cool new-baked oat-cake, overlaid with flower virgin honey, accompanied with a cup of hot strong coffee, mollified with crystallised sugar and cream, such as the butter had been made from, is a breakfast worth partaking of, but seldom to be obtained.

4224. Besides cream, butter is made from the entire milk, which is usually allowed to stand until it becomes sour, and requires a shorter time to convert into butter than when the milk is sweet; but to obtain butter, in either of these cases, a large churn is required, and the churning continued for a long time, seldom less than 3, and often as much as 5 hours. When the quantity of milk is large, power other than human, whether of steam, water, or horse, is employed to move the churn. The butter obtained from this method is very good. The evident objection to this method is, the

labour imposed in agitating so much milk, and in consequently having on hand a large quantity of butter-milk, which, however easily disposed of in towns, would be a drug in the country, unless given to the pigs—or converted into a kind of cheese. The method has its advantages in the uniform character of the butter which it affords at all seasons, from the certainty of obtaining a churning at the proper temperature, which is required to be higher than that of cream, being 60° Fahrenheit, and easily obtained, both in winter and summer, by the addition of warm water amongst the milk. Churning from the whole or *full* milk, as it is called, is thus a comparatively simple process. The milk is poured into coolers at first, and from them “it is drawn off by siphons into vats sufficiently large to contain both the evening and morning meals; and the vats are then put by, to stand totally undisturbed, till the whole acquires a sufficient degree of acidity. The time required for this purpose varies a little, according to the heat of the weather, and the temperature of the milkhouse. The point is ascertained by the formation of a strong thick *brat* or scum on the surface, when this becomes uneven.” All the milk is not of the same age, but this does not affect the quality of the whole. The times of churning are these:—“The milk of Sunday and Monday is churned on the Thursday morning; that of Tuesday, Wednesday, and Thursday morning, on the Saturday evening; and that of Thursday evening, Friday, and Saturday, on the Monday morning.”*

4225. In churning cream or milk, the residuum is *butter-milk*, which, when obtained in large quantity from milk, is disposed of in towns, converted into cheese, or used to fatten pigs; and when obtained in small quantities from cream, a part may be used for domestic purposes, and the remainder mixed with the food given to the brood-sow.

4226. If the butter is intended to be salted, it is somewhat differently treated. After being washed clean as above described, (4219,) it is weighed in the scales, the salt weighed, and immediately applied

to the lump. Practice varies much in the quantity of salt given to butter, as much as 1 oz. of salt to 1 lb. of butter, and half an ounce of salt to 1½ lb. of butter: 1 oz. to 1 lb. is too much, which is like curing butter with as little art as salting herrings. Half an ounce of fine pure salt is quite sufficient for a pound of butter; and which quantity is intended for keeping-butter, for as to powdered butter for immediate use, half an ounce to 2 lb. is enough.

4227. The quality of the *salt* has a material effect on the taste of the butter that has been salted with it. Ordinary sea-salt contains a considerable proportion of other salts than the pure salt, the chloride of sodium, and as these are all bitter, they injure the taste of the butter. “It is easy, however, to purify the common salt of the shops from these impurities,” observes Professor Johnston, “by pouring 2 quarts of boiling-water upon 1 stone or 2 of salt, stirring the whole well about, now and then, for a couple of hours, and afterwards straining it through a clean cloth. The water which runs through is a saturated solution of salt, and contains all the impurities, but may be used for common culinary purposes, or may be mixed with the food of cattle. The salt which remains in the cloth is free from the soluble salts of lime and magnesia, and may be hung up in the cloth till it is dry enough to be used for mixing with the butter, or with cheese.”† The Dutch manufacture pure salt at their works at Catwyck; and this is one reason, no doubt, of their salted butter being so fine, and also so sweet to the taste; and so much superior to the briny butter made in many districts of Scotland.

4228. In the process of salting, the butter is spread out in the tub, after the washing, and the salt, ground fine, is sprinkled over it by little and little, and the butter rolled up and rubbed down with the lower part of the palm of the hand, until the whole mass appears uniformly incorporated with the salt. To insure uniform salting, only half the salt should be applied at once, and the butter lumped and set aside until next day, when whatever of brine or milk may have exuded

* *Transactions of the Highland and Agricultural Society*, July 1843, p. 24-5.

† Johnston's *Lectures on Agricultural Chemistry*, p. 828

from the lump, in the mean time, should be poured off. The other half of the salt should be rubbed in in like manner, and the salted lump put into the jar or firkin on the second day. One great advantage of finishing the salting, and of deferring the making up of the butter until the second day is, that, without it, the butter will not so readily acquire that firm, smooth, waxy texture, which is so characteristic of fine butter.

4229. The state of the kit should be particularly examined before it is used for packing butter. If composed of stoneware, it is easily cleansed and rendered sweet. A wooden kit that has been used before should be filled with water for some time, to render it water-tight by the swelling of the edges of the staves. It should then be repeatedly scalded with hot water, and exposed to the air; and, just before being used, should be rinsed with cold water, and a slight sprinkling of salt scattered over its bottom. A new wooden kit requires somewhat different treatment, because the odour from the new wood will impart a disagreeable flavour to the butter. It should be filled with water mixed with garden mould, or with limeshells and water, for some days, and the mixture occasionally stirred; after which it should be thoroughly scrubbed and cleansed with hot water, and, like an old kit, rinsed with cold water, and salted just before being used. Kits are hooped with iron or with willow rods. The iron hoops last longest, and keep the butter more completely from the air, though they are more costly.

4230. Butter is kitted in lumps, which are pressed firmly down at all points with the knuckles, and great care taken that they be particularly pressed with the side of the forefinger round the circumference of the kit or jar, in substance made solid, no air being allowed to remain in cells, and the surface made even. The surface of the former churning of butter, which had been put into the jar, should be raised up into regular furrows, that the new lump of butter may be commingled with it. The compressing of butter, then, into the kit, is of paramount importance, inasmuch as the least cell of air left in its mass, or that finds access by the side of the kit, will *wind* the butter, that is, impart to it a rancid

taste. After the kit has thus been filled within an inch of the top, the butter is made even and smooth, and covered with a clean piece of wetted white linen cloth. To secure its good qualities, butter should be salted immediately on being made.

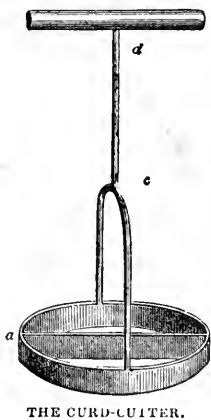
4231. *Cheese*.—The utensils required in cheese-making are a tub in which to earn the milk; a curd cutter; a curd breaker; a drafter to lay across the tub while the whey is straining from the curd; vats for forming the cheese; a cheese press; a furnace and pot for heating water and also milk.

4232. On a farm of mixed husbandry, as much skimmed milk cannot be procured every day as to make a cheese of ordinary size, but a cheese may be made every other day. To save skimmed-milk from souring in warm weather till the next day, it is necessary to scald it—that is, to put it into a furnace pot, to heat it sufficiently, and then to let it cool. The fire should be a gentle one, and the milk should be so carefully stirred as neither to burn nor boil, nor be made warmer than the finger can bear. After being thus heated in the morning, the milk should be poured into a tub, to await the cheese-making of the following day. The skimmed milk of next morning is poured into the same tub, except about one-third of it, which is put into the furnace pot or another one, and made warm for the purpose of heating the entire milk of the tub. The heat is applied slowly to the pot, the milk occasionally stirred with a stick, and made as warm as the finger can hardly bear. This warm portion is then poured into the tub, the contents of which is thereby made as warm as new milk, that is, about 110° or 112°. The degrees of heat just mentioned are rather vague, but I believe no heat is specific in scalding milk, provided the milk is not allowed to burn at the bottom of the pot, or to boil—for if it boil, the milk will coagulate instantly, and be useless for cheese-making, as the cheese made of it would be hard or flinty; and as far as the heating is concerned, the ready and practical test of the finger is sufficiently accurate. On the milk in the tub being stirred, the rennet or earning is added to it, and it is allowed to stand some time to coagulate, with a cloth thrown over it to retain its temperature.

4233. A calf's stomach is usually recommended for rennet; but as calves' stomachs are not easily obtained in districts where calves are reared, a pig's stomach, which can be easily obtained on every farm, answers the purpose as well, and many believe that it makes the stronger earning of the two. When the pigs are killed for hams in winter, their stomachs should be preserved for rennet, and they are prepared in this way: Let the inside skin of the stomachs be taken out: the operation is somewhat troublesome, but may easily be done by an experienced dairy-maid. Any curdling in it is taken out, as being unnecessary, and tending to filthiness, and the skin is wiped clean with a cloth, not washed. It is then laid flat on a table, and rubbed thickly over with salt on both sides, and placed in a dish for 4 days, by which time it has imbibed sufficient salt to preserve it. It is then hung stretched over a stick near the fire, to dry and won, and in the dried state is kept for use as rennet by the next season. Some people place a layer of clean wheat-straw on the skin, after it is salted, and roll the skin over it to keep it open, and after tying a piece of paper round it, hang it up near the kitchen-fire to dry and won. This is also a good plan, but not better than the other. When the rennet is to be used, a brine of salt and boiling-water, sufficiently strong to float an egg, of 3 imperial pints to each skin, is made and sieved through a cloth, and allowed to cool. One skin is allowed to remain in that quantity of brine in a jar, with its mouth covered with bladder, for 3 or 4 days, when the coagulating strength of the brine is tested by pouring a drop or two into a tea-cupful of lukewarm milk; and when considered powerful enough, the skin is taken out of it, it is bottled, and tightly corked for use. The skin is again salted as before, and spread over a stick to dry and won, and made again ready for use when required. Half a tea-cupful of this liquid rennet will coagulate as much milk as will make a cheese of 15 lb. weight.

4234. Fig. 378 is a *curd-cutter*, which consists of an oval hoop of iron *a b*, 9 inches long and 6 inches wide, and $1\frac{1}{2}$ inch deep, embracing a slip of iron of the same depth, along its longitudinal axis *a b*. The

stem *c*, of round iron rod, rising from each side of the oval hoop, unites at *c*, and after attaining in all 18 inches in height, is surmounted by a wooden handle *d*, 6 inches in length, by which it is held by either one or both hands, and, on the instrument being used in a perpendicular direction and pressed down, cuts the curd into as small pieces as you wish in the tub.

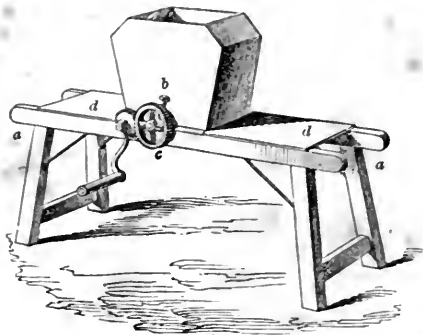


4235. When the milk is sufficiently coagulated, which it will be in half an hour, the curd is cut in the tub with a knife. On being cut, the curd lets out its whey, which is drained off by means of a flat plate being pressed against the curd-cloth, linen of open fabric, spread upon the curd. As much of the whey is removed in this way as practicable; and the curd left is comparatively dry, when it receives another cutting with the cutter, fig. 378, and the whey again expressed from it. The curd is then lifted out of the tub, and wrapped into the curd-cloth, which, in the form of a bundle, is placed upon a drainer similar to *e*, fig. 200, lying across the mouth of the tub, and the whey is pressed out of it by main force. This is the laborious part of the process of cheese-making; and, to save both time and labour in large cheese dairies, the bundle of curd is placed in a large cheese-vat, and subjected to pressure in the cheese-press, or under large weights, to get quit of the whey. A convenient mode of using a large weight for this purpose by one person, is to have it suspended by a chain from the end of an iron lever, whose fulcrum is attached to the point of an arm of wood projecting from an upright bar placed against the wall, and traversing horizontally on its iron heel and top, as pivots, to any convenient point for the deposition of the weight. The curd becomes very firm after this pressing; and in order to reduce it small with comparative ease, it is first cut into thin slices with a knife; and the thin slices are ground down

into a granulated powder by a curd-breaker, before the curd is put into the vat.

4236. The *curd-breaker* is represented in perspective in fig. 379, where *a a* is a

Fig. 379.



THE CURD-BREAKER.

frame of wood, consisting of two bars, connected together with boards *d*, and supported on feet, which are strengthened in their position by cross-bars and iron stays; *b* is a hopper supported by the frame *a*, and occupying the space between the boards *d d*. At the bottom of the hopper is a cylinder of wood, through which an iron axle passes, which rests on either end in plummer blocks on the bars *a*. On the nearest end of the axle is a pinion *c*, having 46 teeth, which is acted on by a smaller pinion of 24 teeth, whose axle also rests in plummer blocks on the frame *a*, and the near end of which bears the winch-handle, which, on being driven round, works the machine. The pin *b*, passing through the upper part of the plummer block, keeps the pinion *c* in its place. The inside cylinder is furnished with three parallel rows, placed diagonally on its surface, of cutting teeth of the form of half a lancet cut through longitudinally, 1 inch long, $\frac{5}{8}$ broad, and 32 in number in each row. The nearest end of the bottom of the hopper inside is furnished with a row of similar cutters, fixed, also 32 in number, which permit those on the cylinder to pass between them when the latter is in motion.

4237. On using this machine, the curd cut in slices is placed in small tubs on the boards *d d*; and on a slice being put into the hopper, the winch-handle is moved round, and the curd is cut in pieces by the teeth, not exceeding a quarter of an inch

in size. A tub is placed below the hopper, to receive the cut curd as it descends from it. In this way one person may feed the slices into the hopper and drive the machine; but the process of curd-cutting is much expedited by one person feeding the hopper with slices, while another drives the handle of the machine.

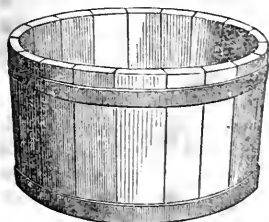
4238. The machine is taken to pieces to be cleaned by unscrewing the pin *b*, when the axle may be drawn out of the cylinder with the large wheel *c*, the cylinder taken out, and the hopper *b* removed from its seat, by turning the thumb-catches which connect it below with the framing *a a*. The small pinion and the winch-handle remain.

4239. The curd, being made small enough, is salted to please the taste with salt ground fine. In some parts, as Cheshire and Holland, cheeses are salted by being floated in a strong solution of salt in water, when the brine penetrates the new-made cheese; but this seems an uncertain mode of giving a desired degree of saltiness. After being salted, the curd is put into a cheese-cloth, spread over a cheese-vat, and firmly packed into the vat higher than its edge; and on the curd being covered with the remainder of the same cloth, the vat is placed in the cheese-press and subjected to pressure, upon which a quantity of whey exudes by the holes in the bottom of the vat. In a short lapse of time, 2 hours or more, the cheese is turned out of the vat, a clean and dry cheese-cloth put in, the cheese replaced into it upside down, and again subjected to increased pressure in the press. Should whey continue to exude, the cheese must again be taken out of the vat, and a clean cloth substituted—in short, a clean cloth should be renewed, and the pressure increased, as long as any whey exudes; but if the previous operations have been properly performed, the exudation should cease in about 12 hours, after which the pressure is continued until the press is wanted for a new cheese on the second day.

4240. Fig. 380 shows the common cheese-vat or *chessart*, as it is called, the form being varied according to that adapted for the cheese. The vat is built of elm staves, as being least liable to burst with

pressure, and strongly hooped with iron, the bottom being strong and pierced with holes, to allow the whey expressed to flow away, and the wooden cover is made

Fig. 380.



THE CHEESE-VAT.

strong by being cross-doubled. It is of advantage that the cover fit the vat exactly, and that the vat be as cylindrical as possible in the interior. In Cheshire the

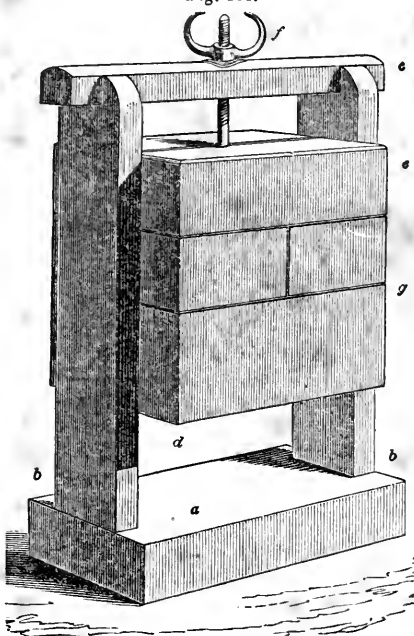
cheese-vats are made of tin, pierced with holes in the bottom and side.

4241. Of the *cheese-press* the varieties are very numerous, though those in most common use may be classed under two kinds, namely, the common old stone press; and the combined lever-press, of which last the varieties are the most numerous, passing from the single lever, through the various combinations of simple levers, to the more elaborate one of the rack and levers. An essential characteristic of these last presses is, that the load, in whatever way produced, shall, when left to itself, have the power to descend after the cheese which is pressed, and which sinks as the whey from the curd is expressed.

4242. The common stone cheese-press is shown in fig. 381; it consists of a strong frame of wood, of which *a* is the sill, two uprights *b b* mortised or dovetailed into it; and these are connected at top by the cross-head *c* mortised upon the posts. A cubical block of stone *d e* is squared to pass freely between the posts; an iron stem of one inch diameter is fixed into the upper surface of the block, and the upper end of it being screwed, is passed through the centre of the top-bar, and the lever-nut *f* is applied to it for raising or lowering the block. In each end of the block a vertical groove is cut, corresponding to the middle of the posts; and a baton of wood is nailed upon the latter, in such form and position as will admit the block to rise and fall freely, while it is prevented falling to either side. When put in operation, the block is raised by means of the screw, until the vat with its contents can be placed upon the sill *a*

under the block. This being done, the nut is screwed backward till the block rests lightly on the cover of the vat: it is let

Fig. 381.



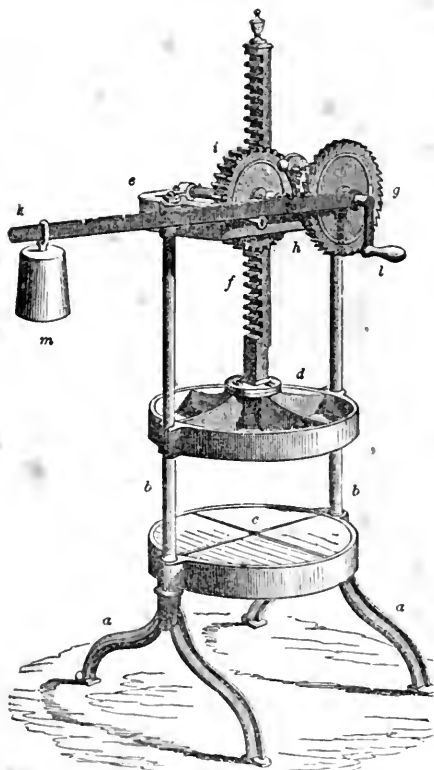
THE STONE CHEESE-PRESS.

down by small additions, as the curd consolidates, until it is thought safe to let the entire weight press upon the mould, which is done by withdrawing the nut *f*. Instead of the solid block of stone *d e*, which, when left to itself, will always produce the same pressure, it is better to have one block *d g* into which the suspending bolt is fixed, and the remainder of the mass made up of smaller pieces, as shown in the figure, by which means the amount of free pressure can be regulated to the particular size and state of the cheese; or blocks of cast-iron are sometimes used in the form last described, which are more commodious, and less liable to be broken. In Cheshire, where cheese-presses of this sort are used, the cheese is subject to three degrees of pressure, the first being a quarter of a ton, the second half a ton, and the third and last one ton.

4243. The *combined lever cheese-press* of iron is represented in the perspective view, fig. 382, and is constructed in the following manner:—*a a* are a pair of cast-iron feet, on which the machine is sup-

ported: they have a socket formed at the crown to receive the malleable iron pillars

Fig. 382.



THE COMBINED LEVER CHEESE-PRESS.

b b. The sill-plate *c*, 18 inches in diameter, is cast with two perforated ears, through which the feet of the pillars *b b* also pass, and secure the sill to the feet,—the cross lines in the sill indicate channels for the escape of the expressed whey. The movable sill *d* is of the same size as the one below, with corresponding ears perforated and fitted to slide on the pillars, and having the rack-bar *f* fixed in its centre. A top frame *e* is seated upon the top of the pillars, and adapted to carry the gearing of the machine. The action of the rack and its sill is effected in the following manner:—The ratchet wheel *g* is fixed upon an axle that has its bearings in the top frame; on the same axle is fixed a pinion of 8 teeth, not seen in the figure, which works in the wheel *i* of 24 teeth, fixed upon an axle which has its bearing also in the top frame; and this

axle carries also a pinion of 8 teeth, which acts upon the rack, but is also hid from view in the figure. The ratchet wheel *g* stands clear of the top frame. The lever *k* is forked at the extremity *g*, and the terminations of the furcation are received upon the axle of the wheel *g*—the wheel being embraced by the fork of the lever, but the lever moving freely upon the axle. A small winch-handle *l* is also fitted upon the axle of the ratchet wheel, and a pin seen near *h* is adapted to a perforation in the top frame, by the insertion of which, the descent of the lever is checked, when such is required.

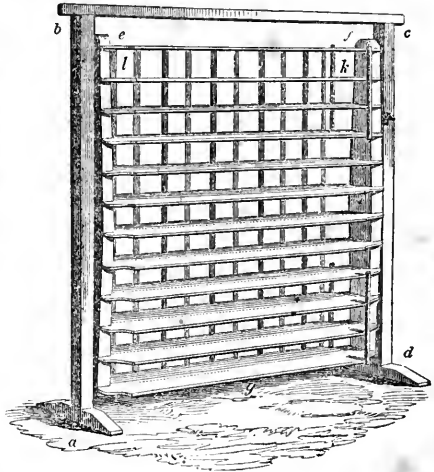
4244. In *pressing* with this machine, the vat is placed upon the lower sill *c*, and the lever being supported on the pin at *h*, the winch-handle *l* is turned to the left, depressing the rack and its sill till the sill presses upon the cover of the vat. The lever is now lifted by the hand, and the pall allowed to take into the ratchet; while the lever, being loaded by the weight, will cause the ratchet to turn, and produce the descent of the rack. If necessary, this is repeated again and again, till a considerable pressure is produced; and if it is wished that a continued pressure is to go on, the lever is again raised considerably above the horizontal line, and left to descend gradually, following the consolidation of the cheese. If it is wished that the lead shall not follow the shrinking of the cheese, the pin *h* is inserted, which, when the lever comes to rest upon it, checks further descent. The amount of pressure is also regulated by the disposal of the weight *m* in the different notches of the lever *k*. The usual selling price of this machine is £4, when constructed of iron as in the figure; but with wooden framework, and the rack and other gearing of cast-iron, the price is £3, 5s.

4245. After the cheese is sufficiently pressed, it is taken out of the vat, and put into the cheese-room *h*, fig. 363, and not exposed to much heat, drought, or damp at first, as heat makes new cheeses sweat; drought dries them too quickly, and causes them to crack; and damp prevents them hardening and winning, and causes them to contract a bitter taste. Exposed to a cool, dry, and calm air upon the shelves *m*, they will dry by degrees, and obtain a

firm skin. The skin becomes harder by being dipped in hot water, but I see no advantage to be derived from such a practice. It should be wiped with a dry cloth, to remove any moisture that may have exuded from it, and the cheese turned daily. Some cheeses burst, and throw out a serous-like fluid, which happens in consequence of whey fermenting which ought to have been pressed out. A cheese that changes its shape raises the suspicion of some organic change going on within it; but if it does not crack, so as to admit the air, it will soon become ripe and be mouldy, and may prove of fine flavour. The inconvenience of cracks is, the facility afforded to the cheese-fly to enter and deposit its eggs in the cheese; and to prevent their egress, the cracks should be filled up every day with a mixture of butter, salt, and pepper, made to a proper consistency with oatmeal. In Cheshire, where the cheeses are made unusually large, they are bound with fillets of linen when removed for drying in the cheese-room, until their form attain a sufficient degree of firmness.

14 inches broad, or more, according to the size of the cheeses manufactured, by one

Fig. 383.



THE CHEESE-TURNER.

inch thick. The shelves are tenoned into and lipped over the posts, and each shelf is finished on both sides with a knife-edged lath, nailed along the back edge. As the figure represents a rack that will contain 5 cheeses on each shelf, a corresponding number of pairs of vertical laths *k*, are nailed upon the back edge of the shelves. The shelf-frame thus formed is provided with two strong iron gudgeons or pivots fixed in the side-posts at mid-height, and these are received into corresponding holes in the outer or bearing posts, so that the shelf-frame swings poised upon the two pivots; and it is further provided with an iron latch at top and bottom on one end, by which it may be tilted and secured with either the shelf *g* or *ef* uppermost.

4246. The *tumbling cheese-rack*, or *cheese-turner*, is a machine invented by Mr William Blurton of Fieldball, Uttoxeter, and its merits are believed to be sufficient to warrant its adoption on dairy farms. The object of the machine is to save much of the labour required in the daily turning of a large number of cheeses in the drying-room; and this it does very effectually, for, with a rack containing 50 cheeses, they are turned over in very little more time than would be required to turn a single cheese.

4247. Fig 383, is a view of the cheese-turner, as constructed to stand alone, and on its own feet; though this is not the best mode of constructing the machine. It consists of an external frame *abcd*, of which *ab* and *cd* have each a cross foot *a* and *d*, and connected at top by a top-rail *bc*. If constructed in a cheese-room, the posts should be at once fixed to the floor at bottom, and to the joisting or tie-beams overhead, becoming thus a fixture in so far as regards the external frame. The second part of the machine is a movable frame or rack, formed by the two interior posts *e* and *f*, which are framed upon the 12 shelves from *e* to *g*, which are each

4248. When cheeses are placed upon the shelves, it will be found that the knife-edge laths keep them free of the body of the shelf, and thus permit air to pass under them, while the pair of vertical laths keep the cheeses in their proper position on the shelf. The height between the shelves is such as to leave a free space of one inch between the cheese and the shelf above it; and whatever number of cheeses may be lying upon the shelves, the simple act of tilting the frame will place every cheese resting on a shelf, on its opposite side, upon that shelf which immediately before

was *above* the cheese, but by the tilting is now *below* it. The vertical laths serve to prevent the cheeses from falling out while the frame is tilting, and each cheese has only to fall one inch in that operation, or from the one shelf to the other, in a reversed position.

4249. It will be also observed, that the fixed external frame is best adapted for an extensive cheese-room, where the racks may be placed in rows extending the length of the room, leaving free passage between the rows. The width of the passages requires to be equal to half the height of the shelf-frame, or 3 feet; a room, therefore, 20 feet wide would contain 4 rows of such racks; and if the length were equal to 10 diameters of the cheeses, or containing that number in the length, the room would contain in all 440 cheeses in the best possible condition for their being prepared for market, having free ventilation, and access for the dairy-maid to handle and wipe any cheese at any time. We have no experience of this cheese-rack in Scotland; but, judging from its apparent capabilities, there is reason to think that it might be employed with good effect in the extensive cheese-dairies of Ayrshire and Galloway. The price of a portable rack, as here figured, capable of holding 55 cheeses, is £4.

4250. The casualties I have mentioned, as befalling cheeses when drying, are less likely to befall skimmed-milk cheese, the making of which I have hitherto been describing, than sweet-milk cheese. These are made exactly in the same manner with the milk as it comes from the cow. One day's milk being insufficient to make a cheese, the fresh morning's milking is mixed with those of the previous day, the oldest part of which will have thrown up a covering of cream, which is mixed through the milk, and the entire gatherings are heated with a portion of the morning's milk. The rennet is applied in the same manner, but in rather larger quantity. Greater difficulty will be found to squeeze the whey entirely from the curd than from that of the skimmed milk; and it is this difficulty of expressing all the whey out of them that renders sweet-milk cheeses more liable to

ferment, and burst, and lose their shape. The best cheeses in Scotland sell from 50s. to 60s. the cwt.

4251. I have not recommended the employment of *annotto* or *arnotto* for dyeing cheese, because I think by it the cheese-farmers impose upon themselves a very useless piece of trouble. It is employed in Gloucestershire to the extent of 1 oz. of annotto to 1 cwt. of cheese; and in Cheshire, 8 dwts. to 60 lb. of cheese, and it costs from 1s. to 1s. 6d. per lb. Annotto is a precipitate from fermentation of the seeds of the *Bixa orellana* of Linnaeus. It is manufactured in two forms, one in *flags* or *cakes* of 2 lb. or 3 lb. each, of a bright-yellow colour, soft to the touch, of good consistence, and comes from Cayenne wrapped in banana leaves, and is much used in giving an orange tint to silk and cotton goods, but which is fugitive; and the other kind is called *roll annotto*, which is small, not exceeding 2 oz. or 3 oz. each, hard, dry, and compact, of a brownish-colour outside and red within, is brought from Brazil, and is the kind used in the dairies. The duty on the roll kind used to be £5, 12s. per cwt., then 4s.; and is now imported free.* When employed, it is put into the milk before the curdling, and it is prepared by rubbing down the requisite quantity in a bowl of warm milk. Dr Ure says, that "the decoction of annotto in water has a strong peculiar odour, and a disagreeable taste. Its colour is yellowish red, and it remains a little turbid. An alkaline solution renders it orange-yellow, clearer, and more agreeable; while a small quantity of a whitish substance is separated from it, which remains suspended in the liquid. If annotto be boiled in water along with an alkali, it dissolves much better than when alone, and the liquid has an orange hue."† All the quantity employed is said to impart no peculiar flavour to the cheese, which, being acknowledged, of what utility is it?—for as to improving the appearance of the cheese, I suppose it will not be denied that Stilton and Dunlop cheese look as well on the table as Gloucester and Cheshire. Marigold flowers, saffron, and carrots, are also employed to colour cheese, and the use of these also imposes unnecessary trouble.

* McCulloch's *Dictionary of Commerce*—art. *Annatto*.

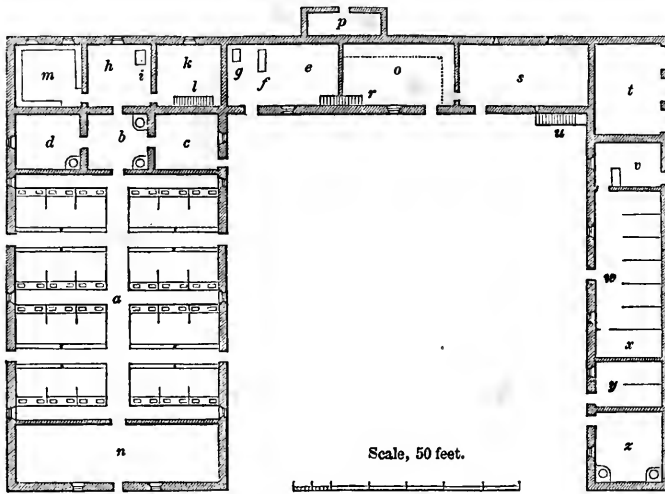
† Ure's *Dictionary of the Arts*—art. *Annatto*.

4252. The dairy operations of a *carse-farm* are confined to supplying milk and butter to its inhabitants. The same remark applies to a *pastoral farm*, whether of cattle or sheep. Dairy-men in towns derive their chief profit from the sale of sweet-milk and cream, and the skimmed milk is readily purchased by work-people. From the dairy-farms in the *vicinity* of towns, sweet-milk, cream, and butter are disposed of; and the butter-milk and skimmed milk sold to the work-people. True *dairy-farmers* conduct their operations irrespective of the immediate wants of towns; and butter is made by them from cream as well as from new milk. Skimmed milk and new milk are made into cheese; the butter-milk is sold to

work-people in the villages, and the whey is given to the pigs.

4253. The convenient accommodation of the cows, and the means of containing and preparing their food, are of paramount importance to the successful conducting of a dairy-farm. A good and commodious *steading* is, therefore, an essential requisite on such a farm. I have already given the plan of a convenient and commodious byre for the cows of a dairy-farm, together with the arrangements for containing their food and preparing it in fig. 93; but to show the entire accommodations which the *steading* of a dairy-farm ought to possess, I give the plan of one in fig. 384, where *a* is the byre, 64 feet long and 54 wide,

Fig. 384.



PLAN OF A STEADING FOR A DAIRY-FARM.

on the same plan as is given in fig. 93; but here it is represented in connexion with the other apartments of the dairy and of the *steading*, and not as an isolated building as shown in fig. 93. The boilers for the preparation of the food are in *b*, which is 17 feet long and 15 wide; the turnips are stored in *c*, 17 by 15 feet; the dairy utensils are washed, dried, and cooled in *d*, also 17 feet by 15; which contains a boiler for heating water or milk; *m* is the milk-house, 17 feet by 15, shelved round; *h*, where the large churn *i* is situated, moved with power, is 17 feet by 15; *k*, an apartment for containing the salted butter, cheese-presses, and the smaller utensils not in immediate use, is 17 feet by 15, and in it is the stair *l* that leads to the cheese-room above, extending over this apartment, the churning-house, and the milk-house, in all 54 feet long and 16 wide; the apartment *e*, 30 feet by 16, contains the hay to be cut with the chaff-cutter at *f*, and the corn-bruiser *g*, for bruising the corn for the horses, both driven by power; *n* is a large apartment, 54 feet by 15, for containing raw turnips and uncut hay for the cows; *o* is the corn barn, 30 feet by 16, situate immediately below the threshing-machine, which, in this case,

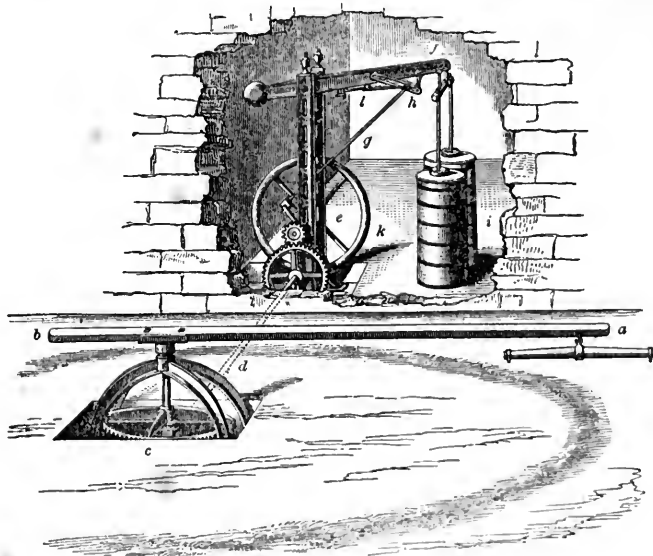
is supposed to be driven by the water-wheel in *p*, but where may be erected the steam-engine, if such power is more eligible; a stair *r*, in the corn-barn leads up to the granary, 30 feet by 16, extending over the apartment *e*; the power for working the chaff-cutter *f*, corn-bruiser *g*, and churn *i* is derived from the water-wheel in *p*, and is accomplished by a lying-shaft with belts and pulleys; *s* is the straw-barn, 35 feet by 16; *t* is the cart-shed, 24 by 18 feet, for accommodating 6 single-horse carts; the outside stair *u* leads to a second granary above the cart-shed, 24 by 18 feet; *v* is the hay-house for the work-horses, 11 feet by 18, having the horse corn-chest in it and communication with the work-horse stable, which is *w*, 43 feet by 18, affording accommodation to 6 horses, and a loose-box stall *x*; *y* is the riding-horse stable, having two stalls 12 feet wide; and *z* is an apartment 18 feet square, containing two boilers—one for preparing the food for the horses, the other for that of the pigs and other purposes. The piggeries, and the byre for the young heifers brought up to renew the cow stock, may be erected at convenient places.

4254. The large churn, moved by power in

extensive dairies, may be of the construction of the box-churn, fig. 374, or of the common plunger churn. As I have already given a figure of the box-churn, I shall now give one of the plunger-churn, moved by power, as fitted up and used in one of the most successful dairy districts of Scotland, Renfrewshire. Fig. 385 gives a view in perspective of the horse-course and churning-room in relation to one another, and which is the more clearly shown by removing a portion of the wall that separates them. The power in this

case is that of the horse, which seems necessary to be adopted where no water is available for the purpose, and where a churn only is to be driven; for a steam-engine, which would only be employed, in such a case as this, every other day, for 3 or 4 hours, and be restricted to give out only one-horse power, would be too expensive an erection for so diminutive an application of power. Where a threshing-machine is used, and chaff-cutters and a bruising-machine employed along with the churn, a steam-engine would be an

Fig. 385.



PLUNGER-CHURNS FITTED UP WITH POWER.

economical source of power. Taking the horse power, in this instance, as the best in the absence of water, *a b* is the lever in the horse-course, to which the horse is yoked by the swing-tree at *a*; *c* is the pit containing the bevelled wheel, and the four arms of the frame which support the upright axle to which the lever *a b* is attached. This wheel moves horizontally, and acts upon a bevelled pinion fixed on the nearest end of the lying shaft *d*, which, being represented in dotted lines, must be supposed to work under ground; and its farther end is attached to and moves a spur-wheel, situated in the churning-room, close to the working gear of the churns. On the bottom of a corresponding pit in the churning-room rise two parallel frames of cast-iron, connected together at the top, and kept asunder by a flanged iron-bar. The reciprocating cast-iron lever *f* is supported by its fulcrum near the top of the frame, by means of a centre shaft passing through the frames. A counterpoise is placed at the short end of the lever *f*, to bring it nearly to an equilibrium. The connecting rod *g* is jointed upon a bolt that is fitted to move along the oblique groove *h* formed in the lever *f*, and the crank to which the lower end of the connecting-rod *g* is jointed is formed on a shaft that

turns in bearings in the upright frames, and which shaft, at the nearest end, bears a toothed pinion which is moved by the spur-wheel on *d*, and at the other end carries a fly-wheel *k*, to equalise the motion of the lever *f*, and compensate for the inequality of the resistance to the plunger-rods in their ascent and descent. The light shears *l* embrace the connecting-rod within its forked end at *h*, and at the other end is connected with an adjusting-screw for the purpose of lengthening and shortening the distance *l h*, and so changing the position of the head of the connecting-rod. The head *f* of the lever is mounted with a pair of side-links, jointed at one end to the cross-head at *f*, and at the other with the wooden cross-head into which the ends of the plunger-rods of the churns *i* are placed side by side. These side-links, jointed as they are at top and bottom, produce an imperfect parallel motion, but sufficient to answer the rise and fall of the plunger-rods.

4255. When this machine is in operation, the revolutions of the crank produce a reciprocating action in the connecting-rod, which is communicated to the lever, and thence to the plungers; and it will be seen that, by moving the head *h* of the connecting-rod in the oblique groove

of the lever, the strokes or reciprocation of the plungers will be short or long as the joint *h* is moved upward or downward in the groove. It is found, from experience, that there are advantages to the process derivable from this; hence, at the commencement of the operation, the head of the rod *g* is kept at the lower extremity of the slit at *h*, producing the shortest stroke. As the milk becomes heated, and, from the consequent effervescence, its bulk is increased, the stroke is gradually lengthened by turning the handle of the screw at *l*, and by thus shortening the distance *lh*, the point *h* is brought to the head of the slit, producing a stroke of the greatest length; and when the effervescence ceases, and the butter has begun to form, the stroke is again gradually shortened, till the process is finished with the shortest stroke. The usual rate of the plungers in these churns is about 50 to 55 double strokes in the minute, subject to the usual variations required in the different stages of the process. The price of this machine, completed with horse-wheel and gearing, is from £15 to £18.

4256. The variety in the quantity and quality of the milk afforded by cows is so great that to account for them requires a knowledge of other causes than the circumstances in which the cows have been bred and fed. I have myself had cows of the same breed which gave as wide a difference as 12 to 25½ quarts a-day, and I have known a cross-bred cow give 45 quarts a-day.* I have had cows whose milk only gave a film of cream in the course of the first 24 hours after being drawn, whilst the milk of others, in the same time, would admit of the cream being lifted off with the fingers. Mr R. Pigott has given his experience of the yield of milk. A Norfolk cow gave 3977 lb. of milk in 39 weeks, beginning to register the quantity a fortnight after calving. A half-bred Scot and Norfolk cow gave 3046 lb., or nearly 17 lb. a-day, for 26 weeks. A true home-bred cow yielded from 16 to 18 lb. a meal, or 35 lb. a-day, 9 weeks after calving. Dr R. D. Thomson states that of the cows he experimented with, one gave from 26 to 22 lb. of milk a-day, and the other from 23 to 21 lb. a-day on grass.

4257. As to the yield of cream from milk, Mr Pigott finds 120 lb. of milk gave 10 pints of cream; which on being raised to the temperature of 52°, by placing it before a fire or in a water-bath, yielded 60 ounces of excellent butter in 40 or 45 minutes of churning. New milk, at 1d. per pint is equal to butter at 1s. per lb.,—1 quart yielding 2½ oz. of butter, after standing in a glass milk-pan for 40 hours. Dr Thomson obtained

from one of his cows 11½ lb., and from the other 8½ lb. of butter from 1427 lb. of grass given to each in 14 days.†

4258. The value of the produce of a cow may be estimated in this way:—a cow that yields half a pound of butter a day throughout the year, and gives 300 gallons of skimmed milk, is a good one. Hence 182 lb. of butter at 1s. per lb. is £9, 2s.; and 300 gallons of skimmed milk at 3d. the gallon, £3, 15s., making the value of her annual produce £12, 17s., exclusive of the manure.

4259. The circumstances affecting the quantity of milk given by cows, are the breed, the kind of food, and the time after calving. The smaller breeds of cows yield the smaller quantity of milk; and the yearly quantity of the large and small breeds has been stated to vary from 4900‡ to 2400 quarts. Cows fed on succulent food, as moist meadow grass, brewers' and distillers' refuse, and new sown grasses will yield a larger quantity of milk than hay, roots, and pasture. Cows, with Dr Thomson, that were fed on grass or steeped entire barley, fell off in their milk from 22½ lb. to 17½ lb., and from 22 lb. to 19½ lb. a day. According to Mr Aiton, a variation in the yield takes place from 1200 quarts the first 50 days, to 300 quarts the sixth 50 days after calving.§

4260. The circumstances which affect the quality of milk are more various. The breed has an effect; the small ones yielding richer milk than the large, in which respect the small Kerry cow is superior to the large Yorkshire. The kind of food, hay, corn, and oil-cake, produce richer milk than turnips and straw, and yield more butter; and bean-meal and tares afford more cheese than oil-cake, corn, potatoes, and turnips. In the time from calving, it is well known that the first milk of a cow, called the beistyn (2248) and (2276,) is much richer than the ordinary milk which the cow afterwards gives. In wet and cold weather the milk is less rich than in dry and warm; and on this account more cheese is obtained in cold, and butter in warm though not thundery weather. The season has its effect: the milk in spring is supposed to be best for drinking, and hence it is then best suited for calves; in summer it is best for cheese, and in autumn for butter—the autumn butter keeping better than that of summer. Cows less frequently milked than others will give richer milk, and consequently more butter. The morning's milk is richer than the evening's. The last drawn milk of each milking, at all times and seasons, is richer than any other part of the milk, and much

* Dr R. D. Thomson, in his *Researches on the Food of Animals*, p. 138, regards the quantities of milk which I gave at page 1275 of the 3d. volume of the former edition, as extraordinary. They were given for such; and a cow that requires to be milked five times a-day, to keep her easy, must be an extraordinary milker. The Scottish pint then used to measure the milk I cannot define; but supposing it to contain three English pints, as stated by Dr Thomson, and two such pints to make a quart, the 17 Scottish pints will make 25½ quarts; and the 30, the extraordinary quantity, 45 quarts, the terms I have now given in the context being more likely to be generally understood than the old Scottish measure.

† Thomson's *Researches on the Food of Animals*, p. 49 and 50.

‡ Dickson *On Live Stock*, vol. i. p. 226.

§ Aiton's *Treatise on Dairy Husbandry*, p. 43-5.

richer than the first drawn, which is the poorest. A cow, before she becomes again in calf, gives richer milk than when she is pregnant, a portion of the secretion which supplies the richer milk being, no doubt, withdrawn to support the fetus. A well-formed cow will generally give more and better milk than an ill-formed one. Old pasture will produce richer butter than new. Cows kept constantly in the byre are said to give richer milk than those allowed to go at large at pasture, but the latter are supposed to yield more cheese,—the exercise, perhaps, preventing the larger deposition of the richer secretion. Many other circumstances may be known in different localities to affect the quantity and quality of the milk of cows; but a sufficient number have been here related to show how varied are the circumstances which affect the produce of the dairy, and how perplexing it must be to conduct it in the most profitable way.

4261. *Milk*.—The phenomena accompanying the changes in milk are well known to every dairy-maid, but few of them know that the constituent parts of milk are only mechanically commixed; and this must be the case even in the udder of the cow, otherwise the afterings, which had occupied the upper part of the udder, would not be the richest portion of the milk, nor the first-drawn the poorest. All, therefore, that is required to separate the different parts of milk is rest and time. The cream or fatty part floats to the surface in the course of a few hours; in a little longer time, according to the state of the temperature, the caseous portion becomes sour; and in a greater length of time the acidity becomes so powerful as to coagulate the milk in one mass, and in a still greater lapse of time the coagulated mass separates into two parts, one becoming firmer, or cheese, the other again fluid, or whey. The rationale of this natural process is thus well given by M. Raspail:—"Milk, when viewed by the microscope with a power of only 100 diameters, exhibits spherical globules, the largest of which are not more than .0004 of an inch in diameter, and which, from their smallness, appear of a deep black at the edges. These globules disappear on the addition of an alkali, such as ammonia, and the milk then becomes transparent. If the proportional quality of milk be more considerable, it forms a coagulum of a beautiful white colour, on the addition of concentrated sulphuric acid. This coagulum does not arise simply from the adhesion of the globules to each other, but it may be plainly seen by the microscope, that the globules are evolved in a transparent albuminous membrane, which has no appearance of a granular structure. Milk, then, is a watery fluid, holding in solution albumen and oil, by the agency of an alkaline salt or a pure alkali, and having suspended in it an immense number of globules, which are in part albuminous and in part oily. The albuminous globules must tend to subside slowly to the bottom of the vessel by their specific gravity, while the oily globules must have a tendency to rise to the surface. But the oily globules being dispersed in myriads

amidst equally numerous albuminous globules, they cannot rise to the surface without taking with them a greater or less number of the globules of albumen. Hence, at the end of twenty-four hours, we find on the surface of the milk a crust composed of two layers, the upper one of which contains more butter than milk, while the lower contains more milk than butter. The separation will take place equally with or without the contact of the air. The liquid part which lies under the crust contains the dissolved albumen and oil, with a portion of the sugar, the soluble salts, and a certain quantity of the albumen and oily globules."*

4262. Milk consists, besides water, of organic substances destitute of nitrogen—sugar and butter; of an organic substance containing nitrogen in considerable quantity—curd or casein; and of inorganic or saline matter, partly soluble and partly insoluble in water. This is the composition of cows' and ewes' milk, according to Henri and Chevalier; and of mares' milk, according to Luiescius and Bondt:—

	Cow.		Ewe. Mare.	
	Beistyn.	Milk.		
Casein,	150.7	44.8	45.0	16.2
Mucus,	20.0	..	..	..
Butter,	25.0	31.3	42.0	trace
Sugar of milk,	trace	47.7	50.0	87.5
Salts, . . . . .	..	6.0	6.8	896.3
Water,	803.3	870.2	856.2	..
	1000.0	1000.0	1000.0	1000.0

Butter gives its richness to milk, sugar its sweetness, casein its thickness, water its refreshing property as a drink, and salts its peculiar flavour. Of the different kinds of milk enumerated, the superior sweetness and thinness of mares' milk are accounted for by the large proportion of sugar and the small quantity of casein it contains. It appears that beistyn contains nearly three times more casein than milk, and only a trace of sugar of milk, no salts, and a large proportion of mucus; and nine times more casein than mare's milk.

4263. Milk boils and freezes about the same temperature as water. Milk may be prevented becoming sour by being kept in a low temperature; in a high temperature, on the other hand, it rapidly becomes sour, and, at the boiling point, it curdles immediately. The acid of milk is called the *lactic acid*, which in its nature resembles acetic acid, the acid of vinegar. "The change which takes place when milk becomes sour is easily understood," as is well observed by Professor Johnston. "Under the influence of the casein, the elements of a portion of the milk-sugar are made to assume a new arrangement, and the sour lactic acid is the result. There is no loss of matter, no new elements are called into play, nothing is absorbed from the air, or given off into it; but a simple transposition of the elements of the sugar takes place, and the new acid compound is produced. These changes appear very simple, and yet how difficult it is to conceive by what mysterious influence the mere contact of

* Raspail's *Organic Chemistry*, p. 380-2.

this decaying membrane, or of the casein of the milk, can cause the elements of the sugar to break up their old connexion, and to arrange themselves anew in another *prescribed* order, so as to form a compound endowed with properties so very different as those of lactic acid.*"

4264. The composition of the ash of milk is as follows, according to the analyses of 1000 lb. of milk each of two cows, by Haidlen :—

Phosphate of lime, . . .	2.31 lb.	3.44 lb.
Phosphate of magnesia, . .	0.42 "	0.64 "
Phosphate of peroxide of iron,	0.07 "	0.07 "
Chloride of potassium, . .	1.44 "	1.83 "
Chloride of sodium, . . .	0.24 "	0.34 "
Free soda,	0.42 "	0.45 "
	4.90 lb.	6.77 lb.

4265. Lassaigne obtained some curious results on observing the composition of the milk of a cow, which he examined at ten different periods, four of these before and six after parturition. The milk examined during the first three of the former periods, namely, 42 days, 32 days, and 21 days *before* parturition, contained no casein at all, but in place of it albumen; no sugar of milk and no lactic acid, but a sensible quantity of uncombined soda. The milk examined eleven days before and just after parturition, contained both albumen and casein; while milk eleven days before parturition, and always after it, contained free lactic acid and sugar of milk, but no free soda. The milks examined 4 days, 6 days, 20 days, 21 days, and 30 days *after* parturition, contained casein and no albumen. It would appear from these observations that the milk of the cow is at first very similar to the serum of blood; and that the casein, sugar of milk, and lactic acid, to which it owes much of its distinguishing characteristics, begin first to make their appearance in it about eleven days before parturition.

4266. Brisson states the specific gravity of various milks: but it is important to remark, that it varies so much, even in the milk from the same animal, that it is impossible to give a correct mean. The specific gravity of cows' milk is low, being 1.0324; its whey is, of course, still lower, 1.0193; and that of ewes' milk is the highest, being 1.0409. Lassaigne examined the specific gravity of cows' milk at various distances of time before and after parturition, at a temperature of 46° Fahrenheit, and the results were generally, that at 21 days before parturition it was highest, being 1.064; and lowest at 6 days after parturition, being 1.033.

4267. *Cream*.—Cream cannot rise through a great depth of milk. If milk is therefore desired to retain its cream for a time, it should be put into a deep narrow dish; and, if it be desired to free it most completely of its cream, it should be poured into a broad flat dish, not much exceeding one inch in depth. The evolution of cream is

facilitated by a rise, and retarded by a depression of temperature. At the usual temperature of the dairy at 50° Fahrenheit, all the cream will probably rise in thirty-six hours, and at 70° it will perhaps all rise in half that time; and when the milk is kept near the freezing point the cream will rise very slowly, because it becomes partially solidified. Lassaigne found no difference in the ratio between the bulks of cream and whey from the same cow, fed on beet-root, hay, and straw, from 42 days before to 4 days after parturition, when the quantities were 200 volumes of cream to 800 of whey; but by 30 days after parturition the volume of cream had decreased to 64, and that of whey had increased to 936, and by that time the water in 100 parts of milk had also increased to 90.

4268. "Cream does not consist wholly of fatty matter, (butter,)" observes Professor Johnston, "but the globules of fat, as they rise, bring up with them a variable proportion of the casein or curd of the milk, and also some of the milk-sugar. It is owing to the presence of sugar that cream is capable of becoming sour, while the casein gives it the property of curdling when mixed with acid liquids, or with acid fruits. The proportion of cheesy matter in cream depends upon the richness of the milk, and upon the temperature at which the milk is kept during the rising of the cream. In cool weather the fatty matter will bring up with it a larger quantity of the curd, and form a thicker cream, containing a greater proportion of cheesy matter. The composition of cream, therefore, is very variable—much more so than that of milk—and depends very much upon the mode in which it is collected." In warm weather, therefore, the cream should be rich, though thin. Cream, at a specific gravity of 1.0244, according to the analysis of Berzelius, consists of—

Butter, separated by agitation, . . .	45
Curd, separated by coagulating the butter-milk, . .	35
Whey,	920
	1000

4269. The quantity of cream which any given milk contains can be easily measured by the *galactometer*, which consists of a narrow tube of glass not more than 5 inches in length, 3 of which is divided into 100 parts, and on being filled with milk to the top of the graduated scale, whatever number of degrees the thickness of the cream embraces, will be the percentage of the cream yielded by the milk. For example, if the cream covers 4 lines of the scale, it is 4 per cent; if 8 lines, 8 per cent.

4270. M. Raspail alleges that the dairymen in the neighbourhood of Paris take off the cream from their milk, and supply its place with raw sugar, and an emulsion either of sweet almonds or hemp-seed. Milk is sometimes adulterated by the addition of starch, and sometimes a portion of carbonate of potash is added to it to prevent it from curdling.† I have detected magnesia

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 1007.

† Raspail's *Organic Chemistry*, p. 385.

in cream in Holland, put in to thicken it. In London, the milk is so adulterated with water, that some dairymen have adopted the practice of driving their cows along the streets, and supplying it to their customers direct from the cow. Both the milk and cream obtained from the dairies in the neighbourhood of Edinburgh are generally free from adulteration. The worst material put into the milk in the public dairies of Scotland is water.

4271. It has been observed that the *Equisetum Arifidile*, the great water horse-tail, gives the milk a leaden or bluish colour, and deprives it of its cream. It is believed that the leaves of the bulbous buttercup, *Ranunculus bulbosus*, is pernicious to the milk, but there is no sufficient foundation for the assertion, as cows will not eat the plant; but it is known that the broad-leaved wild garlic, *Allium ursinum*, is eaten by cows, and gives a most offensive flavour of garlic to milk and cream. This is an annoyance to which the settlers in some parts of Canada are peculiarly subjected.

4272. *Skimmed milk*.—The constituents of skimmed milk, according to the analysis of Berzelius in 1803, are—

Water,	92.875
Curd, not free from butter,	2.809
Sugar of milk,	3.500
Lactic acid, and the lactate of potash,	0.600
Chloride of potassium,	0.170
Phosphate of potash,	0.025
Phosphate of lime and magnesia, with a trace of iron,	0.030
	<hr/> 100.000

4273. "Natural emulsions," observes Professor Johnston, "such as the substance of the nerves and brain, are considered by Mulder to contain a species of chemical compound of the fatty matter with albumen, which has the property of mixing with water. In the nerves of a dead animal, this compound begins immediately to decompose, the fat retreating inwards, and forming a transparent axis, the albumen gathering itself towards the exterior of the fibre. Is milk, then, a natural emulsion, which, while in the udder of the cow, is under the secret influence of the vital power, and which, when drawn from it, begins immediately to decompose, like the substance of the nerves and brain, because the influence of life is no longer exercised upon it!"

4274. *Butter*.—"Butter," says Professor Johnston, "prepared by any of the usual methods, contains more or less of all the ingredients which exist in milk. It consists, however, essentially of the fat of milk, intimately mixed with a more or less considerable proportion of casein and water, and with a small quantity of sugar of milk. Fresh butter is said to contain about one-sixth of its weight (16 per cent) of these latter substances, and five-sixths of pure fat, according to Chevreul.

How much of the 16 per cent usually consists of cheesy matter may be seen by this statement:—two samples of fresh-butter, from cream, examined in my laboratory, have yielded only 0.5 and 0.7 per cent cheesy matter respectively. This is certainly a much smaller quantity than I had expected. Does butter from the whole milk contain more?"*

4275. The proportions of butter yielded by milk varies considerably, from 1 lb. of butter from 15 quarts of milk, as in Holstein, to 1 lb. from 8 quarts of milk of the Kerry cow.† It is a good cow which gives 1 lb. of butter a-day during the season; and perhaps 8 or 9 ounces a-day would be nearer the mark, as the quantity given by the general run of cows over the kingdom.

4276. The changes induced in milk and cream to the production of butter by agitation in a churn, are not yet well understood. It appears certain that the presence of air is not necessary to the conversion of a part of the milk into butter, since a close barrel-churn produces butter as well as an open one. The formation of butter, therefore, must be purely a chemical process, and it becomes the chemist's office to explain the sensible changes which always accompany the churning of milk. These sensible changes are, the milk becoming sour, and the butter being separated from it in a solid form. The sourness of the milk is explained by the change of the sugar of milk into lactic acid, effected simply by a new arrangement of constituents. The separation of the butter from the sour milk, in a solid form, is owing to the breaking up of the envelopes of the globules of fat, and the mutual adhesion of these globules when they come into contact with each other. It is evident that this is entirely a mechanical effect, but it is probably facilitated by the action of the acid thinning away the envelopes of the globules of the fat, when they begin to burst.

4277. Butter consists of two elements, in as far as its fatty matter is concerned—margarin and elain, (1634,) the former giving it hardness, and the latter softness. In winter, the margarin is in greater proportion in butter than in summer, and in cool weather than in warm; for it is possible, chemically, for elain to be partially transformed to margarin, by 1 part of liquid elaic acid absorbing from the air, or from any other source, 4 parts of oxygen, giving off 2 parts of carbonic acid, and becoming transferred to margarinic acid.‡ Such a transference is probable in churning in the open air, but it does not explain the obtaining of firm butter in all circumstances, since as firm butter can be made in a close barrel-churn as in any open one.

4278. *Butter-milk*.—Butter-milk is the portion of the milk or cream which is left by the butter, after the process of churning is finished. It is

* Johnston's Lectures on Agricultural Chemistry, p. 807.

† Journal of the Agricultural Society of England, vol. i. p. 386.

‡ Transactions of the Highland and Agricultural Society, July 1847, p. 62.

sour to the taste, thick, and consists of butter, curd, and water. When fresh, it is a pleasant beverage, and the working classes relish it much as an article of diet at breakfast. When allowed to stand, it becomes sourer and bitter, and is fit only to be given to the pigs, which relish it much as an article of food.

4279. *Curd*.—"The casein of milk," says Professor Johnston, "is similar in composition to the fibrin of wheat, the legumin of the pea and bean, and the albumen of the egg, or of vegetable substances. Hence the opinion first suggested by Mulder has been pretty generally received, that the cheesy matter contained in an animal's milk is derived directly, and without any remarkable change, from the food on which it lives. . . . It appears that, in the presence of sugar, casein is capable of changing or decomposing the fatty bodies also, and of giving birth to oily acids of various kinds. Now, in milk, in cream, and in butter, the casein is mixed with the sugar of the milk and the fats of the butter, and thus is in a condition for changing, at one and the same time, both the sugar into lactic acid, or butyric acid, and the butter into other acids of a fatty kind. Among those acids into which the butter oil is convertible, are capric and caproic acids, which are still more unpleasant to the smell and taste than the butyric acid, and which are known to be present in rancid butter." *

4280. Exact and repeated trials have shown that about 15 gallons of milk are necessary for making about 11 lb. of two-meal cheese, and that 1 lb. of curd is produced from 1 gallon of new milk.

4281. *Whey*.—Whey is the watery substance of milk let loose after the formation of the curd by earing. It has a yellowish-green colour, and an agreeable sweetish taste, in which the flavour of milk may be distinguished. The last portion of the whey squeezed out of the curd is whitish in colour, and contains both curd and butter. Almost the whole of the curd may be separated, by keeping the whey for some time at a boiling temperature. By evaporation, whey deposits a number of crystals of sugar of milk, which constitutes about two-ninths of a per-cent of the whey, the water forming 93·3 parts out of the 100.

4282. Whey is an excellent food and drink for pigs in summer, and particularly for a brood-sow, when suckling pigs. It forms a safe aperient for dogs—no better medicine can be given daily to a pack of fox-hounds out of the hunting season.

4283. From 100 gallons of the whey obtained from sweet milk curd, 10 or 12 gallons of cream may be obtained, from which 3 lb. or 4 lb. of butter may be made in the ordinary manner.

4284. *Rennet*.—The action of rennet consists

simply in the rapid conversion of a portion of the sugar of milk into lactic acid, which acid, like vinegar, has the property of curdling milk. Many substances are recommended to be used as rennet besides the pig's stomach, such as pure curd, agreeable old cheese, the natural fluids of the stomach, the first extract of malt, and sour leaven. After suggesting these, Professor Johnston "particularly recommends trials to be made of the pure prepared curd. If we are able to rescue the manufacture of rennet out of the mysterious and empirical hands of the skilled dairy-maid, and by the use of a simple, abundant, easily prepared and pure rennet, can command at once a ready coagulation of the milk, and a curd naturally sweet, or of a flavour which we had foreseen and commended, we shall have made a considerable step towards the perfection of the art of cheese-making." †

4285. Curd for rennet may be prepared in this way: "Heat a quantity of milk which has stood for 5 or 6 hours, let it cool, and separate the cream completely. Add now to the milk a little vinegar, and heat it gently. The whole will coagulate, and the curd will separate. Pour off the whey, and wash the curd well by kneading it with repeated portions of water. When pressed and dried, this will be casein sufficiently pure for ordinary purposes. It may be made still more pure by dissolving it in a weak solution of carbonate of soda, allowing the solution to stand for 12 hours in a shallow vessel, separating any cream that may rise to the surface, again throwing down the curd by vinegar, washing it frequently, and occasionally boiling it with pure water. By repeating this process three or four times, it may be obtained almost entirely free from the fatty and saline matters of the milk." ‡

4286. *Cheese*.—As the food afforded from 2½ to 3½ acres of land is commonly supposed sufficient for the support of one cow the year round, by taking the medium of 355 lb. of cheese for each cow, the quantity of cheese produced by one acre will be 118 lb., which is supported by the authority of many statements. But during the summer season, cows will afford from 14 lb. to 20 lb. of cheese, or more, in the week, when no butter is made." §

4287. The composition of cheese is as follows:—

	Skim Milk.	Dunlop.	Cheddar.	Ewe Milk.
Water, . . .	43·82	38·46	36·04	40·13
Casein, . . .	45·04	25·87	28·98	33·43
Butter, . . .	5·98	31·86	30·40	19·80
Ash or . . .	5·18	3·81	4·58	6·59
Saline matter, }				
	100·02	100·00	100·00	100·00

The quantity of butter in the Dunlop and Cheddar cheeses is great, and it is it which establishes their rich character.

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 970-3.

† *Transactions of the Highland and Agricultural Society*, July 1847, p. 65.

‡ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 969.

§ Dickson *On Live Stock*, vol. i. p. 237.

is earned by heating in a cauldron; and the whey is separated from the curd by running down an inclined board, upon which the curd is placed before being placed in the cheese-vat. Parmesan cheeses are usually about 112 lb. each in weight, the heavier the better, and sells in retail at from 2s. to 3s. per lb. or £14 to £16, 16s. the cwt.

4294. Cheshire has long been famed for the number of its cheese-dairies. So long ago as 1808, it was estimated that 100,000 cows were used in the dairies of that county, and which produced every year 11,500 tons of cheese of 60 lb. each. The county contains 600,000 acres, one-third of which is in grass; and allowing 2 acres for each cow, the yield of cheese, at that time, would be about 2½ cwt. from each cow. The produce now, 1849, is estimated at 3 cwt. the cow, and some cows give 5 cwt. Cheeses of the weight of 60 lb. each lose about 15 per cwt. of their weight during the first year. Cheshire cheese sells at 8d. per lb. or £3, 13s. 10d. the cwt. in retail.

4295. It is improbable that any farmer, not a dairy one, will try to make a Cheddar or a Cheshire cheese, but many dairy-maids may be tempted to make a Stilton cheese for family use. The following is a good recipe for making one. The cheese-vat is a tin-plate cylinder, 10 inches high, 25 round on the outside, without top or bottom, having the side pierced with holes, to let out the whey. The rennet is made in the usual way, only the stomach of the lamb is used; and in addition to the ordinary quantity of salt used in it, a lemon stuck full of cloves is put into the jar amongst it, the lemon adding to the efficacy of the rennet. About 9 gallons of new milk, and the cream from 2 or 3 gallons of milk, warmed before being put in the milk, are used for one cheese. If sufficient new milk cannot be obtained, the night's milk and cream are used with the morning's milk, as well as the extra cream. The rennet is put in warm when the milk is new; and when it has become curd, it is not broken, but a strainer of coarse linen is laid in a cheese basket, and the curd put into it, breaking it as little as possible; the cross corners of which are drawn together, and it remains in this way some hours, until sufficiently firm to slice. The curd is put in the vat in slices, a layer of curd and a sprinkling of salt alternately: this is continued until the vat is full; then a flat square piece of board is placed at the top of the vat, one having been previously laid at the bottom, placing one hand at the top, and the other underneath. The cheese is then to be turned over very quickly; its own weight is a sufficient pressure; keep turning it every two or three hours the first day and two or three times next day. It is to be kept in the vat three or four days, according to the firmness of the curd. When taken out, a thin piece of calico is dipped in boiling water and wrung out, and then pinned tightly round the cheese. This cloth remains on it until it is thoroughly dry. The cheese should be turned twice a-day; it does

not require any more salt than that which was put in with the curd. It should be a twelvemonth old before it is used, when it may be expected to have a little blue mould, and be rich in taste and mild in flavour. Stilton cheese sells at 1s. 4d. per lb., or £7, 9s. 4d. the cwt. in retail.

4296. Besides the casualties arising from fermentation,

Fig. 386.



THE CHEESE-FLY.—*PIOPHILA CASEI*. 386.

The fly is ready to deposit its eggs in the deepest crack it can find, by means of an extensible abdominal tube. The specific distinguishing characters of this insect are, in the words of Mr Duncan—"About 2 lines in length, the whole body of a greenish-black colour, smooth and shining; front of the head reddish yellow, paler yellow on the under side. Thighs ochre-yellow at the base and apex; tibiae deep ochre, the first and last pair black at the apex; anterior tarsi black, the others ochrey, with the 2 last joints and the claws black; wings clear and iridescent, slightly tinged with rust colour at the base; halteres ochrey."*

Fig. 387.



THE CHEESE-MAGGOT.

The cheese-maggots, fig. 387, are as large as the fly, and commonly called *jumpers*. "When this maggot prepares to leap, it first erects itself upon its anus, as represented in the figure; and then, bending itself into a circle, by bringing its head to its tail, it pushes forth its unguiform mandibles, and fixes them in two cavities in its anal tubercles. All being thus prepared, it next contracts its body into an oblong, so that the two halves are parallel to each other. This done, it lets go its hold with so violent a jerk, that the sound produced by its mandibles can be easily heard, and the leap takes place. Swammerdam saw one, whose length did not exceed the fourth-part of an inch, jump in this manner out of a box 6 inches deep, which is as if a man 6 feet high should raise himself in the air by jumping 144 feet! He had seen others leap a great deal higher."†

4297. When cheese passes its stage of ripeness it becomes mouldy, if kept in a rather damp situation, which all ripe cheeses should be to retain their moisture and flavour, and where the flavour is much enhanced by the production of blue mould. It is possible to inoculate new

* *Quarterly Journal of Agriculture*, vol. xii. p. 126.

† Kirby and Spence's *Introduction to Entomology*, vol. ii. p. 283.

cheese with the mould of old, and thereby at once to impart the flavour of ripeness. This process is easiest done by inserting rolls of moulded cheese extracted by the scoop or *spyer*, into holes previously made in the new cheese by the same scoop, an instrument usually employed by cheesemongers to taste cheese.*

4298. Towards a still further period of decay than this of mouldiness, cheese is attacked by the well-known, and, by some, highly-prized cheese-mite, *Acarus siro* of Linnæus. "We often wonder how the chee-e-mite is at hand to attack a cheese wherever deposited; but when we learn from Leewenhook that one lived 11 weeks gummed on its back to the point of a needle without food, our wonder is diminished," say Kirby and Spence. Both cheese-maggots and mites, when numerous, destroy cheese rapidly, by crumbling it into small pieces, and by emitting a liquid substance, which causes the decayed parts to spread speedily. They may easily be killed, however, by exposure to strong heat, or by plunging the cheese in some liquid, such as whisky, capable of destroying the larvæ, without communicating any disagreeable flavour.

4299. Rats and mice are remarkably fond of, and commit sad havoc amongst all kinds of cheese, but particularly old ones. Nothing but a well-fed cat can deter these vermin from a cheese cellar, where poison cannot be employed with impunity.

4300. Prussic acid is said to have been found by Dr Witing as a spontaneous product of the decay of unsound cheese. "In one experiment, I examined 230 grains of decayed cheese, by digesting it in a small quantity of distilled water, and gently distilling the mixture. The liquid thus obtained had the odour of decayed cheese, and contained ammonia, but not the slightest trace of prussic acid could be detected in it by the most delicate tests. This experiment was repeated with Stilton and other cheeses in various states of decay; but even the sulphur test failed to show that any portion of prussic acid was present. Large quantities of decayed cheese are sold to the poor in London, but we never hear of any effects like those caused by prussic acid resulting from its use. I have found such cheese to be of a brown colour, of a highly offensive odour, and possessing an acrid bitter taste. The decayed portions of the better kinds of cheese, in all stages of animal decomposition, and covered with vegetable growths, are, it is well known, eaten by the epicure also without accident. If prussic acid were produced, as is alleged, nothing could prevent its volatilisation as rapidly as it was formed, unless it was pretended that the acid was fixed! Unsound cheese may act as an irritant, but its poisonous effects are then not due to the presence of prussic acid.†"

4301. The quantity of cheese imported, and entered for home consumption, was as follows:—

	Imported.	Home Consumption.
1847	354,802 cwt.	366,289 cwt.
1848	444,032 „	431,401 „

The import duty, by the tariff of 1846, is 5s. the cwt., and 1s. 6d. when brought from any British possession.‡

4302. According to the microscopical observations of M. Turpin, it would appear that the globules of milk, which in a pure healthy state are always large, numerous, spherical, and alive, become changed in their form and colour when the cow is under the influence of the disease commonly called in France the *cocote*. The *cocote* seems to be the same disease which afflicted the cattle of this country some years since, by rendering their feet hot and sore, and their tongue, and the inside of the mouth, inflamed and blistered, inducing a considerable discharge from it of saliva in a viscid state.

4303. This disease, when it appeared in this country some years since, was considered a new one; but that it visited this country many years ago, may be learned from these observations:—"In the hot summer of 1736, this distemper began under the tongue, and swelled the throat down to the breast, which, if not speedily remedied, kills in a very few hours."§

4304. Amongst the first symptoms of the milk being affected, after the cow has been seized with this complaint, is the change of colour from the natural one to a dirty yellow. The globules become irregular in size, some individual ones acquiring a considerable magnitude, others shrinking in diameter and dying; whilst numbers of different sizes cluster together, and a few, after death, assume a green olive hue. At a more advanced stage of the disease, the globules all die, and become corrugated in the edges, more equal in size, larger, and fewer in number. At a still later date, the globules are of unequal sizes, less regularly corrugated, and much fewer in number, floating about in a serum of a dirty yellowish-green colour, when the odour becomes fetid. "One cannot give the name of milk, at least of pure milk," observes M. Turpin, "to all the liquids which come out of the teats of a cow whose udder is in a state of irritation, and the interior of whose teats is inflamed with pustules. In this pathological state, all the functions of the udder are in disorder, and the three great secretions of the lymph, blood, and milk are wrong. Their respective globules, altered in their form and ordinary colour, lose their special characters, often to the degree of being not recognisable. The particular route which each of these different secretions follows near each other, in a state of health, they break through, and the three kinds of globules, being confounded together, come mixed to the outside by the end of the teats. The cows, sick in the *cocote*, furnish those liquids in that state. It is well to know that milk containing lymphatic and bloody globules is not hurtful to health. We think, in spite of the disgust which it may

* *Prize Essays of the Highland and Agricultural Society*, vol. ix., p. 232.

† Taylor *On Poisons*, p. 697.

‡ *Parliamentary Returns*, 26th February 1849.

§ Ellis's *Modern Husbandman*, vol. iv., August 1745, p. 114.

excite, milk in that state may be nourishing, if the globules, though dead, are entire, and not yet decomposed and passed to a purulent and fetid state. . . . One thing surprises at first, if we do not know that the udder of a cow is composed, by contiguity and connexion, of four distinct udders, each terminating by its own teat, and the functions of which are carried on independently of one another, as much as the separate breasts of a woman—is to see the same cow, affected with the disease, often produce from one of its teats excellent milk, and from another, situated at the same side, a dead inodorous milk, and from a third a purulent milk with a horribly fetid odour. This proves the independence of the sources of the physiological functions of the four simple quarters of the udder, though intimately bound by approximation in one udder.”*

4305. It is in the power of every farmer, whatever may be the kind of farming he pursues, to furnish his table at all seasons, and particularly in summer, with many pleasant and wholesome dishes from his dairy. I shall shortly enumerate a number of those dishes.

4306. *Curd*s are obtained by simply earning a dishful of new milk. It may be served up simply in the dish in which it has been made, or with grated loaf-sugar sprinkled over the curd deprived of whey, which gives it the appearance of a prepared dish, and is eaten with sugar and cream.

4307. A *sour cog* is a dish of milk allowed to stand with its cream until the milk becomes thoroughly coagulated by sourness, and the sour cream and milk are eaten together with or without sugar. It is served in the dish in which it is made.

4308. *Plain cream*, whether sweet or sour, is an excellent accompaniment to oatmeal or barley-meat porridge, (1931.) or to sowens. Without cream, tea and coffee would lose much of their relish; and so would pastry and jellies and preserved fruits. Flour-bread, eaten with cream, makes a nice dessert.

4309. The *clouted cream* of Devonshire is prepared by straining the new-milk into a shallow dish, into which a little warm water has been previously put; and after allowing it to stand from 6 to 12 hours, it is carefully heated over a slow fire or hot plate till the milk approaches to the boiling point; but it must not actually boil, or the skin of cream will be broken. The dish is then removed to the dairy, and the cream allowed to cool, when it may be used as cream or made into butter.

4310. *Milk oatmeal porridge* is more agreeable to the palate than water porridge, and when eaten with cream forms a rich diet.

4311. *Half-churned cream* is a better accompaniment to oatmeal porridge than plain cream, the slight acidity imparting a pleasant taste.

4312. *Cream* may be used as an emulsion with all sorts of preserved fruits, of which it enhances the flavour; and perhaps no form of cream is more agreeable or more generally admired than *blancmange* flavoured with almonds.

4313. *Iced-cream*, flavoured with pine-apple or vanilla, tastes rich and cool in warm weather.

4314. *Cream-cheese*. “One pint of cream being mixed with 12 pints of noon-day milk, warm from the cow, a little rennet is added, and when the curd is come, the whey is poured out gently, so as to break the curd as little as possible. It is then laid in a cloth, and put into a small sieve; the cloth is changed every hour during the day, and in 24 hours it will be fit for use. It may be served on a breakfast plate with vine leaves under it, and it will keep perfectly good only one day.”† A simpler mode is to put rich cream in muslin cloth, and change the cloth until the cream comes to the consistency of taking the form of a mould, when serve on vine leaves or green rushes.

4315. *New churned unwashed butter* is a great treat to breakfast.

4316. *Hatted kit* is one of the pleasantest preparations of milk. Make 2 quarts of new milk scalding hot, and pour upon it quickly 4 quarts of fresh butter-milk; let it stand, without stirring, till it becomes cold and firm; then take off the hat or upper part, drain it in a hair-sieve, put it into a shape for half an hour, turn it into a dish, and serve with cream and sugar. The slight acidity of this dish, with the richness of the cream, and the sweetness of the sugar, combine to make it a very delicious dessert.

4317. *Float-whey* is another preparation equally good as hatted kit, and more delicate. Pour in all the whey drained from the new-milk cheese that has just been made, into a small furnace-pot; apply a slow fire, and raise the whey near the boiling point, but not to let it boil, else the curd will fall to the bottom. During the heating, a scum of curd forms upon the surface of the whey. Take then one quart of fresh butter-milk, and pour it gently over the scum, and as much as until the scum has attained some thickness and consistency. After pouring in some cold water to lower the temperature of the whey, thereby rendering the scum more consistent, skim off the scum upon a hair-sieve, put it into a mould, and on turning it out a short time after, serve with sugar and cream.

4318. To make *Irish two-milk whey*, put two-thirds of sweet-milk into a saucepan, and make it boiling hot; then pour in one-third of butter-milk, gently stirring it round the edges of the pan. Let the whole come to a boil; take it off the fire, let it settle, and strain off the whey, which makes an excellent drink in fever.

* Turpin, *En Mémoires de l'Académie Royale des Sciences*, tom. xvii. p. 214 and 239.

† Dalgairn's *Practice of Cookery*, p. 467.

AUTUMN.

SUMMARY OF THE FIELD OPERATIONS, AND OF THE WEATHER IN AUTUMN.

4319. In taking a retrospect of the different seasons, we have seen Winter the season of *dormancy*, in which all nature desires to be in a state of repose,—Spring, the season of *revival*, in which the returning power of nature inspires every created being with new vigour,—Summer, the season of *progress*, in which nature puts forth all her energies, to increase and multiply her various productions,—and now we contemplate Autumn, the season of *fruition*, in which nature, in bringing the individual to perfection, makes provision therein for the future preservation of its kind. While, however, the natural action of spring and summer is single, that of autumn has a compound character. “Thus, if we follow out the study of the autumn in a proper manner, it leads us to all the revolutions that have taken place in the surface of our planet; and in this way, a plant of which we can, in a few months, see the beginning, the perfection, and the decay, becomes to us an epitome of the system of growing nature in its widest extent, and through its most prolonged duration. This is the grand advantage which studying the productions of nature in their connexion, and the events and occurrences of nature in their succession, has over the mere observations of the individual substance and the passing moment; and it is this which gives to the law of the seasons so high a value above all the beauties of the seasons taken in their individual character.”

4320. Autumn matures its products, in which the toiling labours of the husbandman, for the preceding twelve months, find their reward. In it, hope is lost in the possession of the thing hoped for; and because it yields a plentiful harvest, it is also the season for gratitude and joy. “It

is this which makes the principles of seasonal action thicken upon us as the year advances, and the autumn to become the harvest of knowledge, as well as of the fruits of the earth. Nor can one help admiring that bountiful and beautiful wisdom which has laid the elements of instruction most abundantly in the grand season of plenty and gratitude.” But grateful as the husbandman must always feel for the bounties of Providence, so much labour is bestowed, so much anxiety is felt by him, as regards the effects of the vicissitudes of the seasons, before “he gathers his wheat into the garner,” that the reflections to which the consummation of harvest is calculated to give rise are, I fear, constrained, and even selfish. “For as the annual harvest which we obtain from the earth, is received by us as resulting from that in which we have a right of property, a merit in labour, or both united, we are apt to forget the part which Nature has in the productiveness of the year, and look upon the whole produce as the return of our own capital and our own skill, just as we do in any mechanical work, or mercantile speculation. That this is the true state of the case, is proved by the habitually proverbial fact, that the cultivators of the ground, for what purpose soever they may cultivate, are always complaining of the weather, as the grand enemy by which all their labours are frustrated, and all their products diminished. They are nowise at fault themselves, but the ‘weary weather’ never will be obedient to their dictates. What with rain, what with drought, what with heat, what with cold, each thrusting itself forward at the time when its opposite would have been by far the more beneficial, the crop they get is always ‘below a fair average;’ and what they do get, is gotten in spite of the weather, and not by means of its co-operation. It is in vain that the fable of the farmer—into whose hands Jupiter gave the management of the weather, and who, by having

rain, and drought, and sunshine, and snow, when and where he wished, brought his land into a state of such utter sterility, that he was fain to plead more earnestly than ever, that so dangerous a power might be taken out of his hands—has stood on the record against them from remote antiquity; for the majority contend stubbornly, that all the merit is their own, and that all the blame falls upon the weather, which, notwithstanding all the examples which have been set before it, and all the experience it must have had, ‘will not understand and obey the rules of good husbandry.’”*

4321. The *temperature* of autumn is high,—August in Scotland, affording the highest average of the year, on account of the warmth of the night as well as of the day, though the sun is not more hours above the horizon than in March,—but Autumn follows the radiance of Summer, while Spring just escapes from the frigidity of Winter. Such is the heat, that it is no uncommon occurrence for reapers to be seriously affected by it in the harvest-field.

4322. *Aneroid barometer.* This new instrument has lately been invented by M. Vidi of Paris, for ascertaining the variations of the atmosphere. Its action depends on the effect produced by the pressure of the atmosphere on a metallic box, from which the air has been exhausted and then hermetically sealed. The instrument is so constructed that, as the weight of the atmosphere is increased or diminished, so is the surface of the corrugated elastic box depressed or elevated, as is also at the same time the spiral spring upon which the principal lever rests; and this motion is communicated through the levers to the arbour of the hand. The tension of the box in its construction is equal to 44 lb. At the back of the instrument, which in size is like a large chronometer, is a screw to adjust the hand to the height of any standard mercurial barometer. For comparative observation, the aneroid must be placed in the position for which the adjustment is made.

4323. Mr Belville, of the Royal Ob-

servatory, Greenwich, made simultaneous observations with the aneroid, and a common standard barometer, during the whole of March 1848, at nine in the forenoon and three in the afternoon, and the deviations were very trifling, at least for popular use; and it is his opinion, that, had the mercurial barometer been subjected to the same range of temperature, from 28° to 80°, it would have been equally affected. He finds the movements of the aneroid always consistent. It is a delightful companion, may be carried in the pocket, in a steam-boat, a carriage, in the hand in mounting elevations, without the chance of being injuriously affected. It is therefore highly useful, its indications preventing many an excursion which would have ended in disappointment. The tourist should never travel without it; and the seaman will find it a safe guide when the motion of the mercurial column renders the marine barometer almost useless. In all cases, Mr Belville affirms, in his short but interesting memoir on meteorological phenomena, that he “has used the aneroid as its inventor intended it *should be used*; and its movements are so far perfect that they merit the calm and impartial investigation of the *true philosopher*, whose vocation is to aid the development of ingenuity, and not to crush its efforts because they are not perfection.”† This instrument is extremely delicate in its indications. On this point Captain Mangles relates, that, “for the last twelve years I have used one mercurial barometer, two sympiesometers with oil in the tube, and two more with a mineral solution in the tube: all these I register at ten at night and seven in the morning, and I regularly insert their movements in a diary. For the aneroid, at the beginning of this year, 1849, I had a fresh column ruled; and by this arrangement I soon perceived the forewarning properties, and consequently *greater value as a weather guide*, of the aneroid, as compared with the five rivals. I could cite various instances of this superior sensitiveness, but that of Saturday morning, May 5, 1849, was most remarkable. I was much struck, on coming down at 8, while the sun was shining bright, and there was every appearance of a fine day, to find that my instruments stood thus:—

* Mudie's *Autumn*, p. 25-7.

† Belville's *Description of the Aneroid Barometer*, p. 48.

	Barometer.	Aneroid.	Oil Sympieso- meter.	Mineral Sympieso- meter.
May 4, 10 P.M.	29.82	29.87 $\frac{1}{2}$	29.78	29.75
... 5, 8 A.M.	—82	—6 $\frac{2}{3}$	—78	—75
Difference.	0	5	0	0

Here we have the aneroid in full sunshine, with a bright sky, and every appearance of a lovely day, still uncomfortable and in doubt as to what is forthcoming, while his companions say nothing. I confess that, looking at appearances, while I wrote down my register, I almost doubted whether *this time* the aneroid could be right, but at 1 P. M. I became convinced that there was no mistake. Let me add, that at least four or five times since January 1, 1849, this instrument has given me similar evidence of its superiority as a *forewarner*.* On the day alluded to, a flower-show took place in the Chiswick gardens, and in the afternoon a very heavy rain fell. The aneroid, as a forewarner of weather, thus seems an excellent instrument for the farmer to possess.

4324. In bringing our meteorological observations to a conclusion, I shall confine myself to giving a few results of a general nature. The mean height of the barometer for every month of the year, at Greenwich Observatory for thirty years, from 1815 to 1844, was as follows, according to the seasons as we have all along divided them:—

	Average of each Month.	Average of each Season.
WINTER,	November, 29.801	29.864
	December, 29.884	
	January, . 29.909	
SPRING,	February, . 29.859	29.857
	March, . . 29.857	
	April, . . . 29.865	
SUMMER,	May, . . . 29.884	29.896
	June, . . . 29.910	
	July, . . . 29.894	
AUTUMN,	August, . . 29.890	29.871
	September, 29.872	
	October, . . 29.851	
	Average of the year,	29.872

It seems the greatest *daily* mean pressure for the year occurs about the 9th January, and the minimum *daily* mean depression towards the end of November. It is a remarkable coincidence that the lowest

daily mean temperature, for 30 years, occurs on the 8th and 9th of January. The greatest *monthly* mean pressure occurs in June, and the lowest in November. From June the monthly mean pressure declines till November, when it again rises and attains a second maximum in January; and, again falling, comes to its second minimum in March. During 38 years, the greatest altitude attained by the barometer was in 1825, when it was 30.89 inches; and the greatest depression observed was in 1821, when it was only 27.99 inches.

4325. The phenomena accompanying the oscillations of the barometer of a general character, applicable to all seasons, are these:—A fall of the mercury with a S. wind is invariably followed by rain in greater or less quantities. Great depressions are followed by change of wind, and afterwards by much rain. If the mercury rise with the wind at S. W., S., or even S. E., the temperature is generally high. A rising barometer with a S. wind is usually followed by fair weather. Such a rise, however, is of rare occurrence. Storms of wind, especially when accompanied with much rain, produce the greatest depression of the mercury. No great storm ever sets in with a steady rising barometer. If, after a storm of wind and rain, the mercury remain steady at the point to which it had fallen, serene weather may follow without a change of wind; but, on the rising of the mercury, rain and a change of wind may be expected.

4326. If the weather, during harvest-time, has been generally fine, and a fall of the mercury, with a shower, occur—if the wind turn a few points to the N., and the barometer rises above 30 inches, the weather may be expected to be fair for some days.

4327. *Winds*.—In England, the winds which blow for the greatest number of days together, without intermission, are the W. and W. S. W. They blew strongly for five consecutive days in 1849. The E. and E. N. E. are the winds next most prevalent. The W. winds surge mostly by night, and their average force is twice that of the E. winds. The E. winds are generally calm at night, but blow with some power during the day. On an

* *Gardener's Chronicle*, May 1849.

average, sunrise and sunset are the periods of the twenty-four hours in which there is the least wind. An hour or two after noon is the period when the wind is the highest. As a general rule, when the wind turns against the sun, from W. to S., it is attended with a falling mercury; when it goes in the same direction as the sun, or turns direct from W. to N., the mercury rises, and there is a probability of fine weather. In high pressures the upper current usually sets from the N.; in low pressures it sets from the S. and S.W.

4328. *Rain*.—The following is the quantity of rain that fell in each month at Greenwich, in an average of 25 consecutive years, from 1815 to 1839, arranged according to our division of the year:—

	Average of each Month.	Average of each Season.
WINTER,	November, 2.49 inches.	2.10 inches.
	December, 2.25 ...	
	January, 1.57 ...	
SPRING,	February, 1.56 ...	1.70 ...
	March, 1.71 ...	
	April, 1.83 ...	
SUMMER,	May, 2.01 ...	2.11 ...
	June, 1.91 ...	
	July, 2.41 ...	
AUTUMN,	August, 2.33 ...	2.45 ...
	September, 2.50 ...	
	October, 2.52 ...	
	Average of the year,	2.09

It appears that the greatest average quantity of rain falls in October, and the least in February. The heaviest rains, or those which yield the greatest quantity in the gauge, come down in the summer and early autumnal months. In the summer, $1\frac{1}{2}$ inch will sometimes fall in less than an hour in short but impetuous torrents; in autumn the same quantity will occupy many hours in falling.*

4329. The quantity of rain that falls in the autumnal months as we have divided them, taking the mean as 1, is, according to M. Flaugergues, in

August,	. . .	0.0679
September,	. . .	0.1236
October,	. . .	0.1370
		<u>0.3285</u>

4330. According to the same authority, the number of rainy days in the same period is as follows:—

August,	. . .	16.3 days.
September,	. . .	12.3 ...
October,	. . .	16.2 ...
		<u>44.8 days.</u>

4331. According to Kirwan, after 41 years' observations, in the beginning of every year, the probability of a *dry* autumn occurring is as 11 to 41; of a *wet* one as 11 to 41; and of a variable one, as 19 to 41.

4332. *Clouds*.—The *cirrus* cloud is seen at all seasons of the year, and at all heights of the barometer. If the mercury be falling its changes are rapid, and, on the approach of rain its delicate texture becomes confused, and is ultimately lost in one dusky mass, resembling *ground glass*.

4333. The *cirro-stratus* is also seen at all seasons of the year; and is the immediate precursor of rain or wind, and of a falling barometer. It is in this cloud that *halos*, *parhelia*, &c. are formed.

4334. The *cirro-cumulus* attends a rising barometer. *Coloured coronæ* have their origin in this cloud.

4335. The *cumulus* frequently attends a rising barometer. If, during a fine morning, this cloud suddenly disappear, and it be followed by the *cirro-stratus* cloud, with the wind tacking to the S., the mercury falls and rain soon follows. The *cumulus* usually evaporates an hour or two before; but when it increases *after* sunset, and shines with a ruddy copper-coloured light, it denotes a thunder-storm.

4336. The effect of the *cumulo-stratus* cloud on the mercury appears to be to give it a tendency to rise. It indicates thunder-gusts, showers of hail, and sudden changes of the wind. It is the densest modification of cloud, and, as it passes overhead, it causes a reduction of temperature.

4337. The *nimbus* is never seen with the barometer at great elevations. The

* Belville's *Manual of the Barometer*, p. 16 to 33.

rainbow is the lovely attendant of the nimbus *only*.

4338. The *stratus* is the cloud nearest the ground. Calm weather is essential to the formation of the *stratus*. It is frequent in fine autumnal nights and mornings, sometimes resting on the ground, sometimes hovering some hundred feet above it. It obscures the sun until his rays have raised the temperature of the air sufficiently to evaporate it, when it gradually disappears and leaves a clear blue sky. The *stratus* deposits moisture. It is called the night cloud, and is most frequent from September till January. It has no sensible effect on the barometer.

4339. In hot sultry weather, especially after a slight fall of the mercury, small clouds sometimes suddenly form in a clear blue sky, and as suddenly vanish: this is a sure sign of electricity. If the clouds are without any progressive motion, and increase rapidly, a storm, in all probability, will be in the vicinity; but if they move hurriedly towards any particular quarter of the heavens, the storm will be in the direction whither the clouds are seen to hasten: these signs of thunder are seen, though the storm may be 150 miles distant. In certain states of the atmosphere, when the clouds rise confusedly, and change their forms abruptly, it is difficult for the inexperienced to class them; the prevailing modification of the day, in connexion with the movement of the barometer, is, however sufficient to establish the character of the weather.

4340. "The splendid crimson," observes Mr Belville, "contrasting with the delicate azure of a fine autumnal sunset, and the golden flood encroaching upon the deep blue of a summer's sunrise, are chiefly referable to the lofty *cirrus* and *cirro-cumulus* clouds. Perhaps no climate in the temperate zone can boast, during the fine period of the year, of clouds of so many beautiful and so varied forms as Great Britain. They are the productions of Great Nature's hand, and are anticipated with equal delight by the painter, the meteorologist, and the contemplative mind."* The following lines of a poet, who can feel

intensely as he can depicture exquisitely, seem to supply the moral to the sentiments just expressed:—

"A cloud lay cradled near the setting sun:
A gleam of crimson tinged its braided snow.
Long had I watched the glory moving on
O'er the soft radiance of the lake below.
Tranquil its spirit seemed, and floated slow:
E'en in its very motion there was rest;
While every breath of eve, that chanced to blow,
Wafted the traveller to the beauteous west.
Emblem, methought, of the departed soul,
To whose white robe the gleam of light is given;
And, by the breath of mercy, made to roll
Right onward to the golden gates of heaven,
Where to the eye of faith it peaceful lies,
And tell to man his glorious destinies."
WILSON.

4341. Objects in the horizon—trees, houses, and ruins—are projected in bold relief against the clear cool sky of a calm autumnal evening at sunset. Such a scene as this—if gemmed, moreover, with the radiant and lustrous evening-star—directs the mind to thoughtful meditation, deeply tinged with melancholy. Who would disturb the holy aspiration?

4342. The tension of vapour in the autumnal and winter months, according to our division of the year, is as follows:—

In August, it is	. 10·701
„ September,	. 9·560
„ October, .	. 7·868
Their sum,	. 28·129
<hr/>	
In November, it is,	. 5·644
„ December,	. 5·599
„ January, .	. 4·509
Their sum,	. 15·752

At the approach of winter, when the heat diminishes, the quantity of water precipitated in the form of rain, dew, and hoarfrost, greatly exceeds that which passes into the state of vapour. The quantity of vapour goes on diminishing, while the humidity is continually increasing, and is greater in November and December than in the month of January. This is the origin of the damp cold which characterises those two months.†

4343. *Prognostics*.—The autumnal flora consists of Michaelmas daisies, starworts,

* Belville's *Manual of the Barometer*, p. 28-32.

† Kaemtz's *Complete Course of Meteorology*, p. 92.

APPENDIX TO SUMMER.

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THE general characteristic of this season in the Northern States, is extreme heat, varied now and then by a cool showery day. The thermometer even in the shade occasionally rises to nearly 100 degs. When the extreme sultriness of the atmosphere has become almost unendurable, it is usually relieved by thunder showers, which come up with great rapidity, and rage with a degree of violence such as is seldom, if ever, seen in Europe.

The thermometer, above 90 degs. before one of these showers, frequently falls to below 70 in the course of a few hours; such extreme changes, though in this case delightful as to the bodily sensations produced, are somewhat dangerous to health, and require care in guarding against evil effects.

In June sunshine and showers alternate, but in July and August there are ordinarily from four to six weeks of fine clear sky and warm sun. This whole period not unfrequently passes without a single instance of heavy rain, and sometimes without a drop; although in most years there are passing showers and thunder storms, breaking off for a few hours the harvesters and haymakers.

The dews on clear nights are extremely heavy, and are absolutely necessary for the refreshment of the soil, and of the plants, parched by a burning sun.

Hail storms are not uncommon, and are occasionally of extreme violence, the stones being so large in many cases as to fracture panes of glass, and so abundant as to cover the ground for several hours. The cumulus cloud is far more abundant than any other at this season, and the sun usually goes down quite clear, without the smoky haze which gathers around an autumnal sunset. Light westerly winds continue for many days at a time, veering a little now and then to the north or south, but always preserving a westerly direction.

A change of wind to the eastward at this season is considered an almost invariable precursor of rain; such a change is of itself apt to arrest the progress of haymaking, and to cause preparations for an expected storm.

3000. I suppose that the phenomenon of

hail falling in the hottest weather is usually explained by the supposition that a current of warm air, highly charged with vapor, is suddenly mixed with a very cold current, perhaps from the regions of perpetual congelation above; the consequence is the immediate precipitation of a large quantity of water, which, if the temperature be low enough, is suddenly frozen into drops on its way to the earth, the large lumps being formed by a number of drops united. We usually see in hail storms a whirling motion of the clouds, which may very probably be instrumental in bringing cold currents from the higher regions of the atmosphere, or in carrying warm currents upwards.

I merely give this as the commonly received hypothesis, aware that there are other views which may be strongly advocated. The facts noted in par. 3006 confirm what I have already stated as to whirlwinds. These ashes and bits of straw must evidently have been taken from the surface of the earth, and borne up into the higher currents, where they were frozen into the drops of water, and fell again with that water, enveloped in its congealed masses.

I shall not attempt any additions to the weather wisdom contained in paragraphs 3034 to 3084 inclusive. In every village there may be found old prognosticators who will add numerous maxims even to this collection.

3085. The observations under this head are curious, as showing the different positions which hay holds as food for animals, in Great Britain and in this country. Here, during the winter, it is a main dependence for every variety of stock; there, it is only fed when straw of certain kinds begins to fail; even then, in Scotland, it is given to the working horses alone, and seldom to them before spring. Hay in England is kept for a long time in the stack—several years is not uncommon; and the opinion seems to be that it improves by age. It will be noticed that Mr. Stephens italicizes the words "good old" hay. I do not know of any direct experiments that seem to prove this opinion correct, and am not able at present to see why there

should be any such improvement in the quality of hay from keeping.

3096. Flax is not so largely grown in this country as hemp, indeed it has almost entirely disappeared from New England. It is common, however, in Ohio and other western states. Deep ploughing upon mellow soil is essential to the success of this crop, and also a smooth surface after it is sown.

Crosskill's Clod Crusher, Fig. 243, is a most effective implement for pulverizing and reducing obstinate soils. The numerous toothed wheels, each playing separately from the others, give a grinding motion that cannot be attained by any solid roller armed with teeth, such as I have sometimes seen in this country. These last, too, are liable to clog whenever the soil is a little damp; but in this implement the free motion of the several wheels prevents any very extensive clogging, unless the soil is absolutely wet and sticky. The price, between \$80 and \$90, is an obstacle to their introduction here, but they may very probably be afforded much cheaper soon.

The Norwegian Harrows, Fig. 246, I have never seen in operation, but hear that they work well. These, too, I should judge, must be very expensive, and they do not combine the good effects of rolling with their pulverizing action, as Crosskill's Clod Crusher does. I do not doubt but that, if the farmers demand it, some implement of this description may be got up by our ingenious mechanics at half the prices mentioned here.

Where the linseed is taken from the soil, that is, when the pressed cake is not returned in some form, this is an exhausting crop. To keep the land up, manure may be applied either to the preceding crop, or according to some of the methods indicated in par. 3114. The quantity of seed used in this country is from two to three and a half bushels per acre, a larger allowance than is sown abroad. As the plant is quite hardy when compared with hemp, it may be safely sown by the middle of April.

3131. The culture of hemp, in our middle and western states, seems to be gradually increasing. Kentucky, Tennessee, Missouri, and Indiana, are the greatest producers. The first named state furnishes from 15,000 to 20,000 tons per annum.

Deep mellow soils are selected for this crop; and when all of the operations connected with its preparation for market are conducted upon the soil where it grew, so much is returned that it cannot be considered very exhausting.

American hemp was formerly nearly all dew rotted, and was hence discolored and inferior in quality, being principally used for bagging, bale rope, twine, &c. Of late, water rotting, together with greatly improved

methods of breaking and cleaning, have elevated its character; it is now coming into extensive employment for naval purposes, preference being given for our navy whenever the quality of the article will warrant it. Comparative trials, carefully instituted, between American and the best Russian hemp, have generally, though not by any means invariably, resulted in favor of the former, as superior in strength.

Experience in this country accords with Mr. Stephens' advice, relative to deep and thorough ploughing for this crop. Subsoiling may also be tried with every prospect of advantage.

Cattle should be kept from poaching the fields where it is sown during the winter, and if not quite friable in the spring, they should be ploughed twice and harrowed. Not being remarkably hardy, or well able to bear sudden and excessive changes, it should not be sown until all danger of severe frosts may be considered over. From the 1st to the 15th of May, is usually thought the best time in the middle states.

Seed grown the year before should be used; as, if kept longer than that, it does not vegetate with certainty.

From five pecks to two bushels per acre are recommended. Mr. Stephens, it will be observed, mentions a larger quantity than this. The sowing is generally done broadcast, but drill machines are gradually coming into use, and are found to do the work in a far superior manner.

The roller is a particularly valuable implement for this crop, used after the seed is sown. It causes a more general and even vegetation than would otherwise result, and, at the time of cutting, permits the stalks to be cut quite close to the ground, whereby a great saving, both in quantity and quality, is effected, the lint being heaviest near the root. It is said that an inch here is worth two towards the upper part of the stalk.

When the seed has been covered and rolled, there is usually in this country no after cultivation. When the drill machine comes into extensive use, cultivation in the early stages of growth will be quite practicable, wherever the land has not been well cleared before sowing. As the plant is brittle, and liable to be broken, it is probably the best plan to free the land carefully from weeds, by ploughing and harrowing in advance.

3145. The culture of the hop, on the scale described here, is, I believe, entirely unknown in this country. In England, large portions of some counties, as Kent and Sussex, are devoted to this plant, and it is the main dependence of many farmers. Here the hop is seldom seen at all, and then only in small patches. This cultivation is more expensive

than any other, and requires a large capital to engage in it extensively; on the other hand, the profit is great in favorable seasons.

The Trenching Forks, Figs. 248 and 249, when properly used, are the most efficient implements known for thoroughly stirring the soil to a great depth, without bringing the lower soil to the surface. The great cost of this operation, however, is a bar to its employment even in England, unless in especial cases, and will effectually prevent its introduction here, except for gardens, and, on a small scale, in situations where immediate profit is not an object.

3204. The subject of the sowing and the summer culture of turnips is so fully explained and illustrated under this head, that there seems little left for me to say. Our farmers may study with much advantage the various forms of drill barrows here described and figured, and also the machines for sowing portable manures at the same time with the seed.

The turnip crop is as yet one of comparatively trifling importance in this country, and I do not think that its culture is rapidly increasing. I know that in many districts there are now scarcely any Swedes grown, and but few of the common white turnips, these last chiefly for the table. One great source of difficulty is to be found in that imperfect preparation of the land to which I have alluded as an obstacle in the cultivation of drill crops; when I say imperfect, I mean so far as thorough pulverization and finish are concerned. In many sections, however, the soil is naturally fine and mellow enough; but here we find a fresh obstacle in the awkwardness of laborers unaccustomed to this occupation. As no women work in the field, men must be employed at high wages; they invariably dislike the work, and from want of habit progress very slowly. Then also the time for hoeing generally comes, when all of the men are wanted in the hay field; and after the weeds have once the advantage, it is difficult to recover the smothered crop.

But supposing all of these difficulties to be overcome, there is still another of much importance, in the character of our climate. Its intense heat, and the frequent continuance of dry weather in summer, are all unfavorable to this crop. Many of the plants die, others become stunted, the early growth of all is apt to be slow, and they are thus the longer exposed to the attacks of insects. It is true that they are not always destroyed, and that we have many instances of fine crops; those, in fact, are not wanting who even assert that our climate is better adapted to the turnip than that of England; but in my opinion the weight of evidence and experience, in most districts, preponderates heavily against them.

One of the most effective remedies for these evil influences would, I am persuaded, be found in such machines as Figs. 259 and 261, for sowing bone dust, and other manures of that class, with the seed. A supply of food is thus deposited immediately within the reach of the young plant, and not spread about for the encouragement of weeds; the first growth is consequently strong and vigorous, and it is much more likely to overcome insect enemies, weeds, and all disadvantages of climate.

3236. The method of reducing bones, here described, might prove a good one for the purpose of afterwards dissolving them in sulphuric acid; a small quantity of acid would finish the operation, when they were already in this way so far powdered. The addition of the sulphuric acid is not, as seems to be implied in par. 3237, simply a method for dissolving the bones; the acid in itself adds much to the value of the manure. It has been found a good application alone on many soils, when largely diluted.

It will be perceived that the horse hoes, grubbers, &c., Figs. 263, 264, and 265, are somewhat like our Cultivators, though I think that for the purpose of merely stirring the surface and destroying weeds ours are superior, being lighter, and less expensive. Fig. 264 approaches more nearly to the American Cultivator, but the tines, or rather the shares on their points, are not of so good a shape as in our latest models.

3257 to 3263. Here is described the operation of hoeing, which I have mentioned as so very troublesome to our workmen. These paragraphs are worthy of study by all cultivators of turnips, in order that they may know how to give proper directions to their workmen. Having once learned the right way, they will speedily acquire dexterity. It is astonishing to see how rapidly an expert worker performs this operation. This is shown by the low prices paid for this work in Scotland, from 25 to 50 cents per acre for the singling, or first hoeing of the turnips.

2390. Turnips in this country, in addition to all their other trials, are also exposed to the attacks of insects. The most conspicuous of these is the fly, or striped flea beetle (*Halicta Striolata*), belonging to the same family which has been so destructive in Europe, one of which (*Halicta nemorum*) is mentioned by Mr. Stephens. It appears in May, and continues more or less abundant during the season, frequently destroying a great portion of the crop. There is a small black bug, described as being extremely destructive in some sections, but I have never seen it, and cannot give its name. It may be another member of the above mentioned family.

The pale green caterpillar of a certain white butterfly (*Pontia oleracea*) is also a

serious pest in some seasons. It commences on the under side of the leaf, and eats vigorously until it is ready to change into the chrysalis state.

The remedies or preventatives against insects recommended in England have been also, to a considerable extent, employed in this country. Lime has been used freely, and alkaline solutions. One writer, in an agricultural paper, recommends very strongly to soak the seed in the most offensive tanner's oil, for two or three days previous to sowing. The first leaves, which are always most exposed to entire destruction by insects, are saturated with the smell and taste of this oil, so that their enemies will not touch them; it also acts as an excellent manure. A steep of phosphoric acid in two parts water is said to produce a very wonderful effect in accelerating the growth of the young plants. Sprinkling with the stale liquid from a tanner's lime-pit, or with urine from a tank, has a protective effect at a more advanced state of growth. Unleached ashes, or soot, sown broadcast after a shower, are also good applications.

In conjunction with all these remedies, it is to be remembered that the soil must be mellow and rich, so as to force the young plants quickly forward through the dangerous period. The seed should be sown abundantly, so that some plants may well be spared to the insects, as all remedies will probably fail to keep them off entirely.

While we can grow Indian corn at the north in such abundance, and with comparatively so little trouble, that crop will doubtless maintain its superiority for feeding purposes over all others. This will be partly because of its value, and partly on account of our severe winters, which render it impossible to feed off turnips in the field.

3323. I am happy to find that bones are at last coming into use in this country, and that a few mills are already at work grinding them. The want of such mills has been a most serious hindrance to their use, as the quantity required of the whole bones when they are used must be so very large, in order to produce much effect. Cracking them by hand is both a tedious, inefficient, and expensive process. So far as I know, the mills now established are doing an excellent business, selling all of the bone dust that they can make at good prices. I have no doubt but others would do well in all of our best districts. A large portion of the land in the eastern and older states having been cropped with corn and various other grain crops for a long succession of years, and only having been kept up by ordinary yard manure, is exactly in the condition to be benefited by bones. The phosphoric acid, which they are shown to contain so largely by the analysis cited under this head, is the very substance to supply that which has been

taken from the land by the grain. Hence their effect upon such land is very marked and decisive. In the State of Connecticut, Middlesex Co., much bone dust has been used of late, and the farmers find that their worn out land is brought up by it at once. This beneficial action will continue, if they are careful to keep up the supply of other manures at the same time, so as to be sure that none of the other substances shall become exhausted in their turn.

3331. Much attention has been drawn to the method of steaming bones, here alluded to. It seems that they are thus reduced to a state of extreme fineness, and for this reason produce a most remarkable effect when applied to the soil. Two or three bushels per acre are said to be sufficient. If, however, so great a loss of organic matter occurs as is here mentioned, the process would be scarcely advisable. There might, on the other hand, be some method devised for collecting all of the escape steam and water, and in that case no loss could ensue. The cheapness of this process recommends it.

3332. I entirely agree with Mr. Stephens in the opinions expressed here. The organic part of bones undoubtedly constitutes a large proportion of their value, and should be preserved with care. In the various methods of fermentation described in succeeding paragraphs it is the organic part that suffers, in the partial decomposition which the dust undergoes. If this decomposition is not carried too far, it is of service, by softening the particles of bone, and rendering them more easily soluble. They therefore act more readily in the sustenance of the plant.

3333. This paragraph shows in a striking manner the superiority in phosphates which bones have over common yard manure. Our bones in this country are now collected to a very considerable extent, and are shipped to various parts of Great Britain; so many "bags or casks of bones" are frequent entries in the manifests of vessels bound thither. It is to be hoped that we shall, ere long, know better than to allow such a valuable manure thus to escape us.

3343. I am inclined to believe that guano is not so much the product of the class of birds mentioned, as of some species of penguins, ducks, &c. I have seen their dried bodies brought from the guano deposits, and they resembled birds of these latter classes. This manure seems to have come into especial favor in the middle states, to which the importations are now chiefly confined. It is found to produce there all of the effects ascribed to it abroad, and is eagerly purchased at high prices. I am not aware that we have as yet had many cases of adulteration in this country, but the temptation to some operations of the kind is strong, and as

the demand increases they will doubtless be attempted. Farmers will therefore do well to be on their guard, and if their purchases are not made from parties in whom they can trust implicitly, to insist on a warrantee that will enable them to recover damages, in case that the quality is not what it was represented to be. The most barefaced impositions are now practised in England. Certain parties have lately sold a species of loam resembling Peruvian guano, at a high price, the bags having been previously dusted, both inside and out, with some of the real article in order to counterfeit the true smell. It is not perfectly safe even to buy guano from the vessel in which it was imported, for some houses have lately sent out vessels ballasted with materials intended to be mixed with the true guano as it is discharged into the hold. The only safe way is to buy under the warrant of a certificated analysis, made by some competent person. The farmers could soon force the dealers to have such analysis made upon samples of every cargo imported.

3381 to 3447. Of Mangold Wurtzel, Sugar Beets, Carrots, and Parsnips. These roots are all becoming objects of some attention in this country. The mangold wurtzel is not so much known as the sugar beet; both are, so far as my observation and experience extend, better suited to this climate than the turnip. They are more hardy, less liable to the attacks of insects, and usually yield well. The seed, as Mr. Stephens observes, cannot be sown from most constructions of drill barrows, on account of its size and roughness.

3387. It has usually been thought advisable to soak the seed of the sugar beet thoroughly in warm water before sowing, but it seems that Mr. Stephens disapproves of the practice. If the seeds are dried by rolling in plaster or ashes, that part of his objection relative to drought would be in a great degree obviated, as both of these substances would aid materially in keeping the seed moist. It is advisable for those who wish to cultivate this crop to grow their own seed, as a great part of that which is imported is very poor. It is in all cases best to sow much more of this seed than would otherwise be needed; in the best samples I have seen, a large portion does not vegetate.

The sugar beet keeps very well, and is invaluable during the winter for feeding dairy cows, as it communicates a fine color and flavor to the butter. It has also been used with much advantage for fattening animals. The soil for all of these crops should be well manured and deeply ploughed, besides having the surface handsomely finished. The farmer who attempts to cultivate them on any other system will soon become tired of his unsuccessful efforts.

Carrots and parsnips are also excellent

roots for dairy purposes, and are largely used for feeding to horses. Both these and beets seem to be in this country far less liable to the attacks of insects than turnips. To grow such heavy crops of carrots and parsnips as are mentioned by Mr. Stephens, subsoiling would probably be a necessary preliminary on most soils.

3448. I am not aware that rape is ever cultivated in this country, and do not know that it has any qualities which will lead to its general introduction. The rape cake referred to in par. 3460 is highly esteemed in England as a manure, and has been one chief means of bringing up much of their light chalky land.

3463. Buckwheat is largely cultivated through the northern states. Some examinations of it have been given already in the appendix to Part II. This crop is frequently not sown until July. It grows and matures its seed with great rapidity. It is coming into use as a green crop, and can be grown on land where clover and crops of that class would not flourish. This faculty of growing upon poor soils leads to its cultivation on worn-out land, and hence the crop does not often have justice done it. Probably Mr. Stephens has never experienced the sense of enjoyment consequent upon the partaking of a dish of buckwheat cakes, or he would not have spoken so slightly as to the merits of buckwheat for an article of food.

3473. The sunflower is occasionally grown in this country, for the sake of the oil which its seeds afford, and is said to be very productive. It is recommended by some writers as a valuable article of food for poultry, and is in certain districts now cultivated somewhat extensively. It will grow quite tall, and produce a number of flowers, without much manuring, but the flowers are apt to be small. On a good rich soil they are often eight or ten inches in diameter.

3476. Madia. This plant is not, so far as I am aware, even known in this country, at least as a field crop; and, in fact, its merits seem to be as yet hardly decided upon in Europe. If the product per acre, given in the last part of this paragraph, can be considered a fair sample of its yield, the crop might prove a very profitable one here on dry mellow soils. We are beginning to believe that such seeds as it bears may be of use for feeding after the oil is expressed, and if the latter be such as to take in any degree the place of salad oil, as intimated in par. 3477, then this could hardly fail to prove a highly remunerative crop.

3481. Of the sowing and culture of Maize. I have already noticed the most approved methods now practised in the planting or sowing of Indian corn, and it is not necessary to repeat them here. The difference of climate between the United States and all parts of

Great Britain is so greatly in our favor, as far as regards the cultivation of this crop, that we need not fear any very important rivalry from that quarter in its production. It may, I should think, be introduced there with great success as a green crop, but can fully ripen only in favorable seasons.

3485. It will be found necessary to regard the color, if any particular variety is to be kept pure, as a mixture and consequent deterioration takes place very readily. If black and white, or yellow and white varieties, be planted near each other, some ears of each kind will always be found to contain kernels of the other color, mixed in by a natural impregnation, which, under the circumstances, it seems almost impossible to prevent. Hence, if it is desired to preserve a valuable variety pure, it should be planted in a field by itself, or if there is another field of a different kind unavoidably in contact with it, the seed ears should be selected as far as possible from the source of infection.

Steeps are used with us, as I have before mentioned, but not for the prevention of smut, as that is a disease which is scarcely thought of in this country. A field can seldom be found that has not a few ears of a smutty or fungous growth, but their number is too trivial for notice, and the affection does not seem to have attracted much attention from any source. It can scarcely be the ergot, referred to in this paragraph, and by Professor Lindley, as that disease leaves the grain, both of wheat and rye, so that it may be ground and used for food unconsciously. The ear affected with smut in our fields never attains maturity, but becomes in most cases an almost indistinguishable mass of black powdery substance, losing its shape, and puffing out the outer husks with a species of livid swellings.

3488. I fully agree with Mr. Stephens in the opinion that, as a general rule, catch crops, that is, crops sown between the rows of corn or other plants which are the chief object of cultivation, are no better than robbers of the plants among which they are sown. This does not apply so forcibly to the pumpkin, which is so often sown among the corn hills, as its fruit there thrives and ripens without altering in any way the arrangement and planting of the corn. The pumpkin seeds are dropped and covered with the corn, and require no extra care.

I refer to the practice of sowing beans, potatoes, turnips, &c., in such situations. In the first place, in order to obtain anything worth gathering, the rows of corn must in most cases be placed further apart than usual, and the crop of that grain consequently diminished. The planting must take place at some subsequent period to that of the corn, and this operation, unless done by hand, and

very carefully, is likely to injure the young and tender maize. These are two evils; another one of great importance is, that such a crop, to be worth collecting, must be sown at such a period as to interfere with all cultivation of the corn, except by the hand hoe alone—a most slow and uneconomical implement.

These reasons are sufficient to condemn this course, and I might adduce yet others; they lead us to prognosticate pretty certainly what usually happens in such cases, that the main crop is considerably diminished, for the sake of obtaining a poor secondary crop, which does not repay the extra cost of its cultivation. The farmer has, at the same time, succeeded in exhausting his soil more than he would otherwise have done, and has finally not made so much money as if he had devoted his attention to one crop.

Mr. Keene's recommendation, to protract the thinning until the stalks have attained a considerable size, is unwise in the extreme, as pulling one or two large plants from a hill, without disturbing and in every way interfering with the growth of the others, would be quite impossible.

The thinning should, according to the best authorities, be done at the first hoeing, or in any event as soon as the plants have got beyond danger from the cut worm, an enemy which is quite destructive in some localities and seasons.

3489. The system of managing the maize crop in the latter part of the season, as detailed in this paragraph, does not correspond at all with the results at which Mr. Stephens would himself have speedily arrived, had he ever lived in a region where this crop was one of the staple productions.

It has been well ascertained that the method of topping corn is defective in many ways; the only advantage is, that the tops form an excellent article of fodder, the disadvantages being more numerous and considerable. The cutting of the top, it is true, prevents all further nourishment from flowing to the upper part, that is, supposing nourishment were at this period flowing in that direction at all. My own belief is, that by the time at which corn is usually topped, all circulation is virtually over in the upper portion of the stalk, and that consequently no advantage is derived from the practice.

But if the stalk be allowed to stand till it is time to gather the grain, although the latter is heavy and good, the former is useless as an article of food. The true practice, as I conceive, lies in a mean between the two, which is to cut the stalk at the surface of the ground soon after the ears have glazed, and to cure the whole in small stooks. In this way is obtained a very great amount of fodder, which is considered by many expe-

rienced farmers to be equal to hay when cut for their stock.

But this is not all. We have a result analogous to what has been found to take place in wheat and other grains, when cut just before they are ripe; the kernels are heavier, plumper, and better in quality, than those from the topped corn. The same superiority, though in a less degree, has been repeatedly observed in the kernels from the corn which had been left to stand and ripen without cutting or topping.

It may be suggested, as accounting partially at least for this difference, that the topping process interferes in a very hurtful degree with the natural ripening of the grain. When the top is cut off, the sun and air obtain ready access of course, and exert an increased action upon the stump which remains, causing it to dry up and ripen very suddenly; thus no further movement of consequence takes place among its juices, and the stores which would otherwise have gone into the ear are mostly converted into dry woody fibre. Now, in the corn left standing, or in that which slowly cures in the stook, this action is not so suddenly arrested, and the result is, that the kernels fill out so as to be more plump and heavy. In all cases where corn is cut, and is found to ripen well, it shows that, after a certain period, very little, if anything, comes from the soil; the materials are already stored in the stalk, and we have only to decide what is, on the whole, the most advantageous way to obtain them for our use in the best form, both from the seed and the stalk.

The explanation given above may be incorrect, but that would not affect the fact that the cutting system accomplishes both of these ends much better than any other. The same thing has for years been established in the case of wheat and many other grains, and the practice of cutting corn is gaining most rapidly among all of the best farmers. There are occasionally districts where the contrary practice still prevails, and it is not unusual to see in the midst of heavy stooks the topped field of some man who obstinately refuses to be guided by these new notions. My own observation has seldom failed to show me, that the farm of such a man affords positive evidence that he is lagging behind in many other points, and that he is determinately opposed to book farming, or whatever has not the sanction of antiquity.

3494. I have given some ash analyses under another head, which the reader may compare with those in this paragraph. I must say that these analyses require explanation, both as to the manner in which the ash was obtained, and as to the parts of the plant that were burned. The differences are so great that there must, I think, be something in the circumstances that would show them to

be owing, in part at least, to accidental causes.

3496. On the Germination of Seeds. The observations of Mr. Stephens under this head, and the plates given in illustration, will be interesting to every intelligent farmer. They intimate much more as to the necessary condition of the soil than might be at first supposed. No one can doubt, after careful study of the facts here presented, that air, warmth, and moisture, are of vital importance in germination. The changes which they induce may be re-stated in few words, as follows:—The nitrogenous part of the grain, known in wheat, for instance, as gluten, is altered during germination into a substance called diastase. The nature of this is not as yet exactly known, but it has the power to transfer the starch of the grain from its insoluble state as starch, into a species of sugar; this is perfectly soluble, of course, and is therefore capable of entering immediately into the substance of the young shoot, which must obviously depend for its sustenance upon the parent seed until leaves and a root are formed. The sweet taste of this sugar is actually perceptible to the taste in many young shoots; those of barley, as sprouted for malting purposes, are a well known example.

This transformation, so necessary to the young shoot, so indispensable, I may rather say, cannot proceed if air be entirely excluded, nor if the seed be perfectly dry; warmth also hastens it very materially. Too much water excludes both air and warmth; too great a depth of planting does the same; while, on the other hand, with a very light covering the seed becomes too dry, for lack of that very moisture of which an excess, in the first case, was also fatal. If placed upon the surface, and plenty of water supplied, light comes in to destroy it, with the injurious effects explained in par. 3513.

The object, then, should be, to plant the seeds at a proper and uniform depth, in a well pulverized soil, that may be readily and entirely pervaded by air and warmth. Another important requisite, and one that will, if neglected, be in many cases very essential, is a proper degree of dryness. If the soil is naturally wet it must be drained, or the situation of the seed will be the same as is represented in Fig. 279.

Changes no less singular and important occur in the inorganic part of the seed at the period of germination. One of these may be noticed as an instance. The silica in the grain previous to germination is nearly all insoluble, even in acids of great strength; but now, under the influence of the vital principle, it too becomes soluble, and passes into the young shoot. The ashes of this part are found to contain quite a large proportion

of silica, which has passed into it from the grain.

The foregoing remarks, relative to the peculiar changes of germination, and as to the circumstances of temperature, moisture, &c., that are necessary to insure them, are still more fully illustrated, and brought to a practical bearing, by the cuts from Nos. 283 to 309. It is easy to see that seeds buried irregularly, as in Fig. 287, must be unequally situated as to the effects of air, warmth, and moisture; that some will come up much before the others, making the crop uneven, and that many will not come up at all.

The calculations made by Mr. Stephens, relative to the number of grains sown per acre, of wheat, barley, oats, &c., show most clearly that a remarkable proportion of every crop perishes. A large number of plants, without doubt, die soon after they come above the surface, from the effects of over crowding, of bad weather, or the attacks of insects; and during the whole period of their growth, they are more or less exposed to injurious influences which thin them out; but a still larger number probably never come up at all, for some of the reasons before mentioned, or because they are not well covered.

We may reasonably hope to improve our cultivation, so as to greatly increase the number of seeds which shall vegetate, and grow as far towards maturity as the seed can assist them. This point is reached when the first true leaves are fairly opened, or when the plants are advanced so far as to draw sustenance both from the earth and the atmosphere. After this their progress, in ordinary seasons, depends upon the liberality of the supplies for their nourishment which they find in the soil.

The use of the drill machine for sowing approaches greatly towards perfection, when compared with the ordinary broadcast sowing. The dibble seems to be still an advance from the drill; it is not probable, however, that dibbling will find much favor with us at present, as it would undoubtedly prove far too expensive.

The saving of seed by these improved processes is of itself a matter of very great importance, when we consider the quantity sown over the whole country. Par. 3538 illustrates this point quite forcibly. The question as to whether thick or thin sowing grows the better crop seems not to have become as yet quite clear, although the weight of the evidence which Mr. Stephens has collected appears to be decidedly in favor of the latter method. It is obvious, however, that it is not safe to reduce the quantity of seed to the measures mentioned in these paragraphs, where broadcast sowing is continued. Very thin sowing cannot be expected to succeed on poor, scantily manured land,

for under such circumstances the crop will not by any means tiller so as to cover the ground. On the other hand, very thick sowing will not answer on such land, for the plants will not be able to find enough sustenance, and will consequently grow up stunted and spindling. A medium between the extremes would be best for most of our farmers, at least until they have brought their land up so that it will bear quite thin sowing.

3554. This paragraph, with the two succeeding ones, very intelligibly explains a fact which experience has shown to many of our farmers, that there is a great advantage in deep sowing for winter wheat. In the western counties of the State of New-York they have found it a complete, or almost complete, remedy to the winter killing of their wheat, which was formerly a very great evil. They now sow it deep, either with a drill or by covering with a light furrow by a set of gang ploughs. Figs. 293 and 294 sufficiently illustrate the benefit of this proceeding. In the same connexion, par. 3557, we see why spring wheat should be but lightly covered: it has no frosts to bear, and must spring up and mature rapidly, without time for tillering; hence the long pipe of communication between the coronal and the seminal roots is not necessary, and in fact must be a source of disadvantage, as the young shoot from the seed sown so deep would be a long time in reaching the surface.

3564. It is not necessary to pause upon the subject of transplanting wheat longer than to say, that in this country, at our present prices of labor, every grain of wheat saved in this way would be an illustration of the old maxim, "penny wise and pound foolish."

3566. On Repairing Fences, &c. I would call the attention of farmers to the remarks of Mr. Stephens on the necessity of looking carefully to fences before cattle are turned into pastures. When the fields of different owners join, it very often happens that one of them neglects his portion of the fence, and, in consequence, the other has either to suffer from stray cattle, to build the fence himself, or go to law. This last alternative is a disagreeable one, and most men are properly reluctant to excite the unpleasant feeling and enmities which almost always arise from it. Every farmer should therefore make the care of his fences a primary object. If he has not the proper and honorable feeling which would induce him to do this for his neighbor's sake, self-interest should lead him to it. If cattle or sheep are always confined by well constructed and firm fences, they never acquire a roving disposition; but if they have once been tempted to escape through a weak place, they seldom forget the lesson of liberty they have learned, and

make it a practice to deliberately try every available point, until they find an opportunity to break out again.

Gates are becoming much more common than they once were, and are gradually replacing the inconvenient and troublesome bars. It must be admitted that bars are cheaper, and less liable to get out of order, than gates; but on the other hand is to be considered the time occupied in taking them out and putting them in, and their liability to be left down by careless persons passing through them.

The great obstacle in our northern climate to the general introduction of gates is, the difficulty of setting the posts so that they will not sag with the weight of the gate. The frost goes so deep that, unless the greatest caution is used in setting the posts, they soon get thrown out of the perpendicular. By digging the holes deeper than is common, and by employing more care in filling them, I am inclined to think that a great part of the trouble would disappear. The plan recommended in par. 3575, and shown in Fig. 295, is a good one. I have also known of posts being set in a horizontal wooden framework, running with the fence. If all the parts of this framework are charred, or otherwise protected from decay, such a post will stand firm for a long time.

I might present many ingenious plans of gates and fastenings, but they abound in our agricultural papers already, and the farmer can easily make his selection therefrom. The wire gates now coming into vogue will, I think, be excellent for field purposes. They may be made with a good strong frame, and then, with the aid of perhaps two or three braces, would bear quite hard usage.

3576. In this country trees are almost always found to serve the purpose of rubbing posts; where there are none in a lot, these may occasionally be necessary, but rail fences of almost any kind are equally convenient.

3577 to 3669. On the disposal of fat Sheep and Cattle. I suppose that many of the rules contained in these paragraphs, relative to judging of the condition of fattening stock, may be found very useful to the farmer who has not had much experience in such matters. They will enable him, after a little practice, to form as correct a judgment of his stock as the drover himself could do.

There is one point, however, well worthy of attention from American farmers, which comes out distinctly in different parts of these paragraphs. It is the references to fairs and gatherings for the sale of cattle as of frequent occurrence, and as the markets to which every farmer looks. It seems to me that, in this respect, we might learn a good lesson from the English farmer. We have nothing analogous to the numerous county and village

fairs which are held at stated periods in all parts of Great Britain. If a farmer here wishes to buy a lot of sheep or cattle for fattening or other purposes, either in the fall or spring, he is obliged, after purchasing what he can advantageously in his own vicinity, to wait for a passing drove from which to make a selection. This may not come at the right time, and may not suit him as to price or quality when it does come; he may, therefore, be either disappointed altogether, or forced to buy what does not exactly please. If he wishes a pair of working cattle, or a horse, he must leave his work, and drive about the country often for days, before finding anything fit for his purpose or within his means. I might go on to mention many other inconveniences connected with the present system, but every practical farmer knows them better than I.

That there is a growing feeling on the subject, is proved by the numerous attempts now making in various parts of the country to connect sales of stock and of implements with the county and other fairs. This is an excellent way of making these fairs still more important, and more popular, than they have ever been. If they could be made places to which, at certain times, stock of all kinds will congregate for sale as well as for exhibition, the interest of the masses in them would augment wonderfully. Buyers and drovers with stock would be drawn together, from a distance, more or less great according to the importance of the fair. By one influence or another, the people of a whole county or district would thus be gradually gathered in to take a part in the fair, if not for the sake of improvement, at least as buyers or sellers.

The farmers would then have the great advantage of a large market, and of knowing prevalent prices. They would not require to spend an occasional day or half day haggling with this drover or that, during the whole season, finally selling under the market, perhaps, from ignorance of its state; but would finish all their business of this kind at a fixed time, and then could return to their usual occupations, and be free from interruption.

I am aware that this could not all be brought about at once. It would require time to convince people as to the advantages of such a system. Many would at first feel disposed to condemn it entirely, and refuse to countenance any of the fairs; but if they were continued, all would gradually see the benefit of a fixed market, and be driven from their prejudices into cordial acquiescence.

It might even be found advantageous to carry this system still further, and have weekly, or monthly, or quarterly, grain and produce markets, such as are held in all parts of England. The circumstances of the locality

must decide this, but in many places such markets would be of much service. The sales are mostly made by sample, and then the farmer can make delivery at his own convenience, within a certain period. It is evident that in this way much time would be saved, and the farmers thereby enabled to work more economically in the disposal of their crops. Accustoming them to this system would also be a work of time, but I think they would all by degrees fall into it. The manner of conducting the Scottish stock fairs is very fully explained in these paragraphs.

It is easy to see that such fairs, when once established, would gradually become markets for the sale of implements, household utensils, and all articles of value to the farmer.

3730 and 3731. The recommendation given in these paragraphs is worthy of attention. The effect of lime upon mountain pastures is almost always beneficial in this country. It is not invariably applied as burned lime, or crushed carbonate, or marl, but sometimes as a sulphate, that is, the common plaster of Paris. This, employed as a top dressing, is in many cases the most effective addition that can be made; a small quantity often causes a wonderful alteration in the color, luxuriance, and quality, of the grass. In some places it does not succeed; but where it does, the effect is very marked. Plaster is little used in England.

3732. The bush harrow described here, Fig. 304, gives us an idea of a much more perfect and effective implement than those generally used in this country. A heavy frame of this kind would last for a very long time, and would be always ready when wanted. The farmer, having it at hand, need not spend an hour or two in looking about for a bush to his mind, but could make an excellent harrow with any little refuse boughs that happened to be near. There would also be a further advantage, in the ability to load this harrow so as to make it press more heavily on the ground, by fastening an extra stick or two across from *a* to *c*.

3752. The sheep bot fly (*Cephalemia Ovis*) of Harris seems, according to some figures that I have seen, to be a different insect from *Aestrus Ovis*, mentioned by Stephens. There are, however, other American authors who call the fly which is found here *Aestrus Ovis*. As I have no specimens, I am unable to decide whether they are actually the same. It is doubted by Mr. Randall and others, whether the larvæ of this insect really do any harm, beyond the irritation and excitement which they cause in their ascent and descent of the nostrils.

3753. The sheep tick (*Melophagus Ovinus*) is well known in this country, and occasionally becomes quite troublesome. When a

flock is infested with them, they are sure to leave the old sheep soon after shearing, and find their way to the lambs. An effectual method for driving them from this refuge is, to dip the lambs into tobacco water, leaving only the nose and eyes above the surface, and allowing them to remain immersed for a minute or two. Some cover the nose with the hand, and then dip them entirely.

3743. The sturdy, or turnsiek, here spoken of, caused by hydatids, is little known on this side of the Atlantic, and some writers of eminence say that they have never yet seen a case; others assert that they have known a few instances; it is evidently, however, not common.

The scab caused by acari is a disease which seems also to be much less prevalent here than abroad. One reason for this may be, that short woolled sheep have been more common than long woolled, and it is the latter class that are said to be most liable to this disease.

3754. I cannot find that the blowflies, mentioned in this and succeeding paragraphs, have attracted much attention in this country, as being injurious to sheep. They are not mentioned by some of our best authors on the affections of sheep. Our diseases seem to be, in fact, as regards this animal, of a character differing considerably from those that prevail in Europe.

3757. The worrying of sheep by dogs has become such a serious matter in some of our states, that many farmers are prevented from keeping sheep, or have sold their flocks from this one cause; not being willing to endure the trouble and vexation caused by the depredations of worthless curs, whose visits it is almost impossible to detect, so cunning do they grow in the practice of their profession. Movements are making in many parts of the country for the passage of stringent laws bearing upon the subject. A tax of some kind on all dogs in sheep districts would tend to reduce the number to those that are actually of service; and heavy fines levied upon the owner of every dog proved to have killed a sheep, would still further mitigate the evil.

3761. The ravages of caterpillars on our grass lands do not in general seem to be extensive. In the eastern part of New England, a caterpillar of one of the arctians or tiger moths is sometimes very destructive on the salt marshes, but does not seem to go far inland. We have many varieties that are exceedingly injurious to trees.

3762. The grub of the cockchafer, described and figured here, is of the same class as those of numerous Scarabæans that abound more or less in this country. They are occasionally very abundant in old grass fields, but I have never found them so numerous or so destruc-

tive as they frequently are in England. Many of these are with us more to be dreaded in the perfect state than in any other. The rosebug or rosechafer (*Melolontha subspinosus*, Fab.) may be mentioned as one of the worst. Its ravages are spreading, and it no longer confines itself to the rose, as was the case at first, but attacks grape vines, destroying even the grapes themselves, and is a source of very great annoyance to the gardener. Its eggs, according to Harris, are usually deposited from the first to the middle of July, and the perfect insect comes out from the earth early in June of the succeeding year.

3766. On the Pasturing of Cattle in Summer. I do not know that I can add anything of importance to these remarks upon the summer keeping of stock. They are generally practical, and are all adapted to this country, as well as to England.

Our permanent pastures and meadows deserve more attention than they have ever had. It is not uncommon to see those of many years' standing which scarcely produce enough to pay for the fencing of the land: they are in a state of almost entire exhaustion. Such pasture should either be ploughed and properly cultivated, or be brought up by top dressing. This last is perhaps the most expensive and tedious of the two, but I have seen it adopted with great success in situations where it was not desirable to break up the turf. Simple top dressing, if persevered in, will after a time extirpate many troublesome weeds, and bring in good grasses.

3777. It is greatly preferred in this country to leave one or two trees in each field, for shade and shelter. A tree affords a cooler and more agreeable protection, during the heat of summer, than any ordinary shed, and may be left standing in some position where it will not materially interfere with ploughing.

3803. The bot flies, which lay their eggs upon cattle and horses, appear to be the same here as in England. The large spotted bot fly (*Gasterophilus equi*) is most common. There is also the small red tailed species (*G. hemorrhoidalis*), and the brown farrier bot fly (*G. veterinus*). It is affirmed by some writers that the first named species lays its eggs on the knees and legs of the horse, the second on his hips, and the third upon the throat and breast. We have also the *Oestrus Bovis*, or ox bot fly, whose maggots live in holes on the backs of cattle, causing the warbles, as they are called in Scotland.

The chief of our large horse flies appears to be *Tabanus atratus*, of Fabricius. It is black, with a whitish bloom on the back; its body is often more than seven eighths of an inch in length, and the wings expand two inches. This fly is an object of terror to cattle, and renders them extremely uneasy when at work. It may be easily killed after

it has fixed itself for its meal. The *Tabanus cinctus*, or orange belted horse fly, is smaller, and not so abundant as the larger variety.

The most common of the smaller kinds is *Tabanus lineola*, named from a whitish line on the top of its body. Several other species of *Tabanus* appear at the end of June, and continue to torment both horses and cattle through the hot months.

There are various kinds of golden eyed forest flies that become exceedingly troublesome in the woods and thickets, during the months of June, July, and August. Their eyes are very brilliant, their bodies rather slender, and they have clouded or banded wings. They are much smaller than horse flies; some are quite black in their bodies (*Chrysops ferrugatus*, Fab.), others are striped with black and yellow (*Chrysops vittatus*, Wiedemann). They issue from the bushes on a hot summer's day in such swarms, and bite so fiercely, as to render a horse, not thoroughly protected by nets, almost frantic, covering his neck and other defenceless parts with blood. Cattle are so annoyed by them, in many cases, as to be prevented from feeding quietly during a considerable part of the day. A wash made from a strong decoction of walnut leaves, applied daily to the back, neck, and ears, is said by some writers to be a protection.

The greater part of the foregoing facts were obtained from a valuable work, *On Insects Injurious to Vegetation, &c.*, by Dr. T. W. Harris, Librarian at Harvard College.

3869. I am disposed to agree with Mr. Stephens, that soiling on a large scale is only practicable under certain conditions, such as where the soil, situation, and climate, are all favorable to the production of an abundant growth of green fodder in the middle of summer, at a time when that essential article would ordinarily fail on most farms. In all other circumstances than the above, it would be necessary to sow some crop intended to come in at just about the period when the grasses commonly give out. Indian corn is probably the best crop for this purpose; being equal to any in nutritive properties, and superior to all in bulk. It should be sown broadcast, or in drills very close together.

This system does not seem to be exactly in accordance with nature, and it may well be questioned whether an animal, always cooped up in a stall, with but occasional visits to a confined yard, can be as healthy as one which, during the summer months at least, has its freedom, and constantly breathes the fresh air. There can be no doubt but a greater quantity of manure may be made in this manner, if due care is taken to prevent evaporation and washing away, both of which causes exert a great influence upon manure dropped by the animal in the field. A considerable

portion of this must always be lost, and on the spot, where it falls so much richness is concentrated, that, for some months at least, nothing does well. These remarks relate to the solid manure. It seems obvious that a larger portion of the urine would be saved in an open pasture, where it falls upon, and soaks directly into, the ground, than could be preserved with the utmost care by collecting in tanks.

3877. The scythes and snathes that are used in this country by far excel anything that I have ever seen in England or Scotland, both for convenience, elegance of form, and lightness. The best snathes, curved to suit the height of the workman, the handles fitted with screws, so that they can be adjusted to any angle or part, the convenient method of fastening and shifting the heel without the use of wedges, and the whole balancing of the implement, are unapproached by any foreign article that I have ever seen or heard described. The grass nail, shown at *f* in Fig. 322, is never used on our scythes, and would be considered a useless and troublesome appendage. A properly shaped snathe does not catch grass at the heel, and, unless it may be in mowing among clover that is badly tangled, never needs anything of this kind.

3900. Of the Washing and Shearing of Sheep. I find it difficult to add much to the full details given under this head. In this climate sheep cannot ordinarily be sheared with safety much before June. The plan of washing recommended, that of passing the sheep from one hand to another across the water, is evidently an excellent one. It is much better calculated to insure thorough work than when each man takes and finishes a sheep. We have learned, however, in this country, that the *bottle* figured in the corner is not a necessary accompaniment to sheep washing: and find that our men not only do not suffer for want of such a stimulant, but that, on the contrary, they are far better without it.

3915. The methods of shearing, and the positions in which the sheep is held during the process, do not differ materially from those that we often see practised in this country.

Some of the best flock masters, with a view to the ultimate character of the fleece, recommend washing the sheep in vats, having a fall of water upon them of about two feet in height. The vat is made large enough for three or four sheep to swim in. A platform is built under and around it, extending to clean grass. The washer stands upon this platform, and is not compelled to go into the water at any time. It is considered best by some to wet the sheep thoroughly in the vat, and then to restore it to the pen for an hour

or two, before finishing the washing. In this way it is said that a remarkably white and clean fleece is obtained.

Many farmers take this opportunity to clip the hoofs of their flocks, while the horn is softened by the influence of the soaking in water which it has undergone.

The shearing is uniformly done on the barn floor. Some shearers use low tables, but the greater number prefer the level floor itself. It is considered a good day's work to shear twenty-five merinoes. There is no doubt that the neatness of this operation is often interfered with by carelessness, and the condition in which some flocks are turned out after clipping is lamentable. The hint conveyed in par. 2928 should be taken, that when the wool is very closely and smoothly sheared, the next year's fleece is the better for it, and clips easier.

The flock, driven into the shearing pen in the morning, should not be more than a half day's work; as the sheep are more easily and better sheared when their stomachs are distended, and full of food, than when they are empty and collapsed.

3934. Extra care and labor in tying up the fleece, in keeping it scrupulously clean, free from burs, straws, &c., will always be well recompensed, by the advanced price which such wool brings. In place of forming a rope from the fleece itself, I have always seen common cotton twine used for tying. This seems a more convenient plan, and less calculated to injure any part of the fleece.

A clean, tight, dry upper room, is preferred for the storing of wool; and it is much better if plastered, as more effectually excluding mice, insects, dust, &c.

A very good way of packing wool is, to suspend the sack through a hole in the floor, or, if it be in a lower room, from a scaffolding. A man first descends into the sack, and an assistant passes the fleeces to him. He carefully arranges them in layers, and presses them firmly down with his feet, thus gradually filling the bag in a most regular and compact form.

3979 and 3987. On the summer culture of Beans and Peas. I have already mentioned that these crops are not of very great importance among us, and consequently our experience can add little to the directions here given for their culture. It is said by Mr. Harris, that beans are liable in dry seasons to suffer from the attacks of one of the *Tettigoniada*: or Leaf Hoppers. These little insects commence their attacks in June, and continue through July and August, till the vines or stalks, and the pods, become shrivelled and worthless. He calls this species (*Tettigonia Fabæ*.)

The pea weevil (*Bruchus Pisi*) is well known in this country, and indeed is said by

some writers to have originated here, and to have been carried hence to Europe. Its attacks are almost universal, and it is very seldom that a parcel of peas can be found without them.

3993. On the Weaning of Lambs, &c. Ewe milk cheeses are almost unknown among us, and so, in my experience at least, are all of the precautions in milking the ewes daily, for a time after the lambs are removed. In using tobacco water for driving away ticks, as I have before recommended, the lambs should be dipped in an oblong narrow trough, three or four feet in depth, and having on one side an inclined grating with a board under it. The dipped lamb is laid on this grating, and its wool pressed with the hand; the water is thus squeezed out, and, falling through the grating upon the board, runs back into the trough. If the lambs are dipped every year, this remedy is said to be completely effectual in banishing ticks from the flock. Five or six pounds of the cheapest plug tobacco, or even of the stems, will make a decoction sufficient for 100 lambs.

4015. On the Marking of Sheep. It is common to mark each sheep with the owner's stamp as soon as it leaves the hands of the shearer. If a hot pigment is used, it is kept ready at the extremity of the floor by which the sheep pass out. A mixture of tar and lampblack is much employed, and forms an exceedingly durable mark, but is only removed from the wool at the factory with great difficulty; hence the manufacturer prefers to have oil and turpentine substituted for the tar. The mark is made either on the side or the rump, and it is customary to mark ewes and wethers on different sides.

There are many ingenious systems of ear marking in vogue among large owners, but it does not seem proper to occupy space here by undertaking their description.

4023. The farmers of New England, as a class, are certainly not liable to the imputation here cast upon the Scotch farmers, of a lack of skill in haymaking. If there is any branch of their profession that they understand well, it is this. I have nowhere seen so much hay of a uniformly first rate quality as in some districts of New England.

In many parts of the State of New York they allow the grass to become almost dead ripe, so that in fine weather they can often cut it and carry it to the barn on the same day. This is doubtless a saving of labor, but it is more than balanced by the loss of quality in the hay.

During the ripening of grass, a very large portion of the sugar, and other kindred bodies which the green stalks contain, is converted into dry woody fibre; at the same time, the fatty matters and nitrogenous substances, for the most part, go into the seeds. A large

proportion of these seeds, and of the leaves also, is shaken off in the process of curing and transportation; so that, with clover hay in particular, little else finally remains than a bundle of dried, indigestible, stick-like stalks. I am aware that in some districts farmers say that they are driven to this practice by the pressure of their grain harvest, which will not allow them time to cut their hay earlier. It seems to me that, by a little management and foresight, they might in some way contrive to obviate this difficulty, and so get hay of vastly improved quality.

The cutting of the first crop of hay is almost entirely done in the months of July and August. The usual custom is to commence cutting in the morning, with all hands that are capable of wielding a scythe. Two or three boys follow the mowers, shaking the grass out of the swathes. When as much grass is cut as the company can take care of, the scythes are laid aside, and all join in spreading from the swathes any that may still remain. When this is done, it is usually time for luncheon under some shady tree. All of the hay is then turned, before dinner with forks or rakes. After dinner it is turned again, and by three o'clock raking should begin. It is a great secret in haymaking to have the hay all raked in winrows and cocked before the dew begins to fall, which is soon after four o'clock. If put up warm and entirely dry, it cures in the cock during the night, and, once turning in the morning after opening will, unless it has been very green when cut, render it fit for the barn. If, on the contrary, it has been damp in the cock, a much longer time is required for drying on the next day; and if rain comes on, it is far more likely to injure by standing.

The raking was formerly all done by hand, and is still in many secluded districts; but on most farms we now appreciate that invaluable implement, the horse rake. Some rakes, much like Fig. 343, or modifications of the same form, have been introduced; but the most common, and, as it seems to me, most advantageous form, is the ordinary revolving rake, Fig. 351. It is firm in all of its parts, not liable to break, easily worked, and very rapid in its operation. One horse and a man keep from six to ten men in active employment at cocking and raking between the cocks. The cross beam of the revolving rake being smooth, slides over the ground with great ease, so that the work is not hard upon the horse. It is a great resource when threatened by the sudden coming up of a shower, and the farmer who has one is able to proceed with confidence in the execution of far more work than he would otherwise dare to undertake.

I am astonished to see from the directions given in paragraphs 4051 to 4058, that, in some parts of Great Britain at least, they have

not as yet begun to understand the capabilities and the true usefulness of this implement. If they had done so, we should never have been presented with such a plate as Fig. 347, where all hands are seen pushing the hay together with forks; while the horse rake seems to be considered at the top of its capacity in raking between the winrows, as in Fig. 348. Its great value to us in saving labor, consists in its power to rake the hay very rapidly into winrows.

The hay tedding machine, Fig. 342, is scarcely known in this country. I remember seeing one several years ago in an old out-building, where it had been laid aside as useless, but know little of its operation. My impression is, that it is not adapted for our purposes, and would not do the work with sufficient rapidity.

On the morning of the second day, the mowers do less work than on the first, because they have that which was mown on the day before to shake out of the cocks, to turn once or twice, and in the afternoon to carry to the barns. There is thus always a certain number of loads to carry away, and a certain number to cock. After a few days it is discovered how much the force can manage, and all goes on regularly.

The chief points to be observed in the making of hay are these:—

1. To cut the grass while a considerable portion of it is yet in flower.

2. To cut no more than can be properly attended to.

3. To commence the shaking out of the partially dry hay as soon as the dew is sufficiently dried off the ground.

4. To be active in turning during the middle of the day, and to do it *thoroughly*, leaving no locks unshaken. When the hay is nearly made, little shaking is necessary; but when green it should be well shaken, and made to lie as evenly as possible.

5. To commence the raking in good time, so that the cocks shall be put up before the hay begins to feel damp and flexible in the hand.

If the carting and cocking be finished before night, the men will have leisure to grind their scythes for the next day's work, and often to do some mowing. The grass that is cut at this time is, of course, not shaken out, but lies in the swathe till morning.

I have thus described the common mode of cutting grass, and of haymaking. Some farmers are now adopting a plan more nearly resembling the English. In place of employing all of their hands at mowing, they engage one, two, three, or more, according to the scale of their operations, to cut the whole of the grass at so much per acre. These men keep on steadily at their cutting, and a sufficient number of other hands take charge of

the haymaking and carting. Two or three men, working constantly in this way, will cut enough grass to employ several times their number of haymakers.

If bad weather occurs for days in succession, it is a part of the agreement that the mowers shall stop until it clears. There is always hoeing enough at this season to employ them, when the weather is such as to admit of out-door work.

In managing on such a system, some calculation is required to apportion the force rightly; so that the mowers shall not be able in good weather to overwhelm the haymakers, and, on the other hand, that the latter shall have an abundance of work. When so conducted, it is without doubt a most agreeable and economical plan. I have known instances where, by the adoption of this method, the whole cost of cutting, making, and storing, was but from \$2 to \$2.50 per ton.

Owing to an almost universal preference for large barns and barracks for storing crops, stacks are comparatively rare, and are hence, from want of practice in their make, very different from the neat ones that are made in England. There, where such directions as those given under this head are followed, stacks are put up in such a way as to resist the effects of storms and wet weather most perfectly. When a haystack is cut down, it is seen that the rain has not penetrated in any direction more than a few inches from the surface. So also with grain: it keeps in these stacks for years, if necessary; only being liable to the attacks of vermin, which are perhaps still more destructive in a barn. The fashion so commonly followed in Scotland of placing the stacks upon stands supported by pillars, thus cutting off all access to rats and mice, seems to be an effectual remedy against their attacks.

Our farmers would do well to study these directions, so that in case of necessity they may know how to build stacks that shall be at the same time handsome and weather-proof.

4042. I am not aware that rick cloths, such as those shown in Fig. 346, have ever been used in this country; and as most of our hay is stored in barns, they are not likely at present to be necessary. A cheap barrack could almost be put up for the price of one of them. I have often thought, however, that a cloth of smaller dimensions, an old sail perhaps, or some cheap India rubber cloth, might be useful for covering a load of hay from a sudden shower, or covering a large heap in the field. It often happens that a load of dry hay is overtaken before it can possibly be driven to the barn, or that several loads are caught in the field, either quite dry or very nearly so. If such hay is thoroughly wetted, its value is greatly deteriorated. If it could be hastily

raked by the horse rake, and then thrown into large heaps, to be covered by a few of these cloths, made of small sizes for the purpose, a great saving might be effected, and this usually several times in the course of each season.

The hay hand rakes, Figs. 344 and 345, are seen to be very clumsy implements when compared with those made by our own mechanics. Our rakes are lighter, wider, more effective, and at the same time sufficiently strong for all proper uses. A large hand rake, first used, as I am told, in the south of England, has been introduced within a few years, and has met with very general approbation in the New England States, and wherever it has become known. The form and general efficiency of this rake have been greatly improved since its first appearance here. The head is about five feet in length, and the teeth eight or ten inches. The handles enter the head in the same style as shown in Fig. 344, but are of course larger, and are somewhat bowed upwards for convenience in drawing. It is especially efficient in raking after a cart while loading, and also in cleaning up the scatterings among hay-cocks. In such situations a man or boy, drawing one of these, is able, with great ease to himself, to do the work of two or three using the ordinary hand rakes. They are also useful in raking a grain stubble after the stooks have been carted.

4080. The mode of attaching the beater to the flail, explained here, and represented by Fig. 350, is, as it seems to me, very inferior to our way of placing a cap on the head of the handle, which plays freely around it, and only requires a simple thong passed through the bow of the cap to effect a secure fastening. This is a light, handsome mode of fastening, and is quite as durable as any other that I have seen. Flails are still almost universally employed in the New England States; but at the west, and in many of the middle states, they have gone almost out of date, except that they may be occasionally seen in play for some particular purpose, as the threshing of grass seed, or a small sample of seed grain.

4089. On the Summer Culture of Wheat. But a short time has elapsed since the idea of hoeing wheat, or any other grain crop except corn, was received in this country with perfect derision; now, however, farmers begin to appreciate the evil of weedy grain fields better than they once did, and, since the introduction of the drill machines, some enterprising individuals have really begun to consider the expediency of adopting the horse hoe also. I have no doubt but we shall see it in operation on some farms before a long period of time. Such an implement as Fig. 353 might be made cheaply in this country,

and has a very efficient look. Many farmers have tried hand weeding for particular weeds, and with good success. A weed hook, like Fig. 352, is well adapted for this purpose, and I have seen a straight chisel used to good effect.

That this proposition, as to the necessity of weeding grain, is not ridiculous, can be easily ascertained, and in a manner to satisfy even the incredulous. Let any person take the trouble to look over such fields of grain as lie nearest to his residence; the charlock, the thistle, the yellowdock, the wild parsnip, and many other weeds, will be found abundant in most situations; while in some sections the Canada thistle monopolizes a lion's share, rendering it nearly impossible to bind the grain.

Now, in the first place, a great part of these pests might be exterminated by more care in ploughing, harrowing, and clearing the land; and, in the second place, by caution in applying any description of manure in which large quantities of undecomposed seeds might remain.

Many weeds may be exterminated quite readily by sending boys into a field, armed with such implements as were mentioned above. If stimulated by an offer of so much per thousand, and their ambition excited, there would be no fear of idling. Few farmers have any idea as to the extent of ground that is occupied by weeds. I remember the case of a ten acre field, in which the wild parsnip became rather abundant. A casual observer would have said that there might perhaps be from 200 to 300 in the whole field. The crowns of the roots were cut off by a straight chisel, and the tops counted. There were actually rather more than 1200 of them. If these could have been all collected, and shown growing in one plantation, no farmer would have questioned the expediency of eradicating the whole; and yet, growing singly about the field, they were larger, and occupied individually more room, than had they been close together.

It is always to be borne in mind that, when weeds are thoroughly rooted out, a comparatively small amount of labor afterwards will keep them down. The farmer whose fields are infested, whose crops are almost smothered in weeds, looks upon the work of exterminating them as entirely beyond his means; he wishes that they were away, and still cannot quite muster courage enough to attack them. But if he only commences clearing each field thoroughly, taking care not to stock it again by impure seed or foul manures, he will soon find the labor decreasing. After the business is accomplished, little more than vigilance is necessary to keep down the first stragglers that appear. A year or two of neglect will soon renew the old difficulties. I have seen

large farms in England and Scotland where weeds were scarcely to be found at all, and some few in our own country that also approached to this condition. The amount of labor required to keep such farms clean is not by any means equal to that expended on other farms, in vainly struggling against weeds which have obtained such an ascendancy as to threaten the existence of everything else. It is now ten years since the field which I mentioned above was thoroughly cleared of wild parsnips, and to this day they have not reappeared in any number. A single one occasionally shows itself, but is pulled up at once.

On our ploughed land the most obnoxious weeds are the Couch grass (*Triticum repens*), the Knot grass (*Arrhenatherum arenaceum*), and the annual meadow grass. The leek, or wild onion, is excessively troublesome on certain light soils. We have, in short, imported nearly or quite all of the worst foreign weeds, and have reinforced them by various specimens of native growth, such, for instance, as the Canada thistle (*Cirsium arvense*), which hold their ground, as natives should, even more obstinately than the foreigners.

Our roads are too often nurseries for weeds, and frustrate all attempts at clearing the adjacent fields. Every farmer who means to be entirely triumphant, must see that this source of supply is cut off. The weeds around the margins of fields, in the angles of fences, and in the sides of ditches, should also be carefully kept down.

There are in many places laws intended to enforce the cutting of weeds by the roadsides, but they are too generally allowed to become a mere dead letter.

Daisies can be driven out by enriching meadow land, and even the Canada thistle will yield to an obstinate course of cutting. It must not be left long at a time, but kept cut, so that it may never have an opportunity to gain strength.

4107. Above all of the insects which have been noted for their ravages upon the wheat crop, the Hessian fly (*Cecidomyia destructor*) stands pre-eminent in this country. It belongs to the same genus as the British wheat fly, or wheat midge (*Cecidomyia tritici*).

Our naturalists are, I believe, now all agreed in considering this insect to be of European origin. The popular, and probably correct belief is, that it was brought hither in some straw by the Hessian troops who landed on Long Island in the summer of 1776. From what we now know of the habits of this insect, this was the only period of the year when it could have been conveyed across the Atlantic. It appeared almost immediately after this time on Long Island, and gradually spread itself over the country, advancing at the rate of about thirty miles in a year. Like

all other insect ravagers, it has occasionally seemed to disappear almost entirely, and then has returned with new vigor, and in increased numbers.

There are two broods or generations in each year; one in the spring, and the other in the autumn. It seems doubtful if the eggs are laid on the grain at all; there appears, however, to be a certainty that a great portion, if not the whole, are laid in the longitudinal cavities of the leaves, while the plant is still quite young.

When the maggots are hatched, which is in about twelve to sixteen days, they crawl down the leaf, and work their way between it and the stalk, until they reach the first joint; here they fix themselves, and appear to live by sucking the juices of the plant, until they are ready to go through their transformation into the pupa state. In this state they have been likened to flaxseed.

The insect remains thus during winter, and comes out in its perfect form in April and May. It then lays its eggs upon the spring sown wheat, and such of the autumn sown as may have escaped in the preceding year. Some observers insist that the fly does actually lay its eggs on the grain, and that the maggot is therefore obliged to crawl down, either in the interior or on the exterior of the stalk. This may be so, but numerous accurate investigations have established the fact that the eggs are also laid on the leaf. If they are laid on the grain as well, we see how remarkably nature has provided for the continuance of this species.

There are certain varieties of wheat that have been found competent, under almost all circumstances, to resist the attacks of this insect pest. Some of the best of them are the Underhill, the Spelter, the China, the Mediterranean, and the White Flint. These are generally strong, hardy kinds, and manuring highly is found to be an assistant preventive, the plant making such a vigorous growth as to overcome the assaults of its enemies. Feeding off the wheat fields during autumn and spring, with cattle and sheep, greatly reduces the number of the fly. Late sowing avoids the autumnal deposit of eggs, but, unless this sowing be deep, exposes the plant to winter kill. Burning the stubble immediately after harvest, and then ploughing and harrowing the land, destroy great numbers. As the eggs are laid to a considerable extent upon barley and rye also, these crops should be treated in the same way as wheat. Such is the substance of the remarks made upon this subject by our most eminent naturalists.

There are several parasites especially devoted to the destruction of the Hessian fly. The chief of these is a small four-winged fly (*Eurotyma destructor*). This insect lays its

eggs in the pupa, when it is in the flaxseed state.

There is an insect, resembling in its habits the Hessian fly, which attacks barley, and it also has its four-winged parasite. The wheat fly, which has occasionally been quite destructive in various parts of the country, is probably none other than the English wheat fly (*Cecidomia tritici*). Its habits and described appearance agree with those given by English naturalists. It is advised to cease for a year or two from autumn sowing where these insects abound, and to sow very late in the spring. Fumigating the fields with sulphur has been tried, and also strewing newly slaked lime, or wood ashes (unleached), over the wet plants. Both of these methods are said to have been successful.

There is a wheat worm, or wheat caterpillar, which has occasionally committed great ravages, but we are not yet well acquainted with its character and habits. From the descriptions, it is a true caterpillar, and makes its depredations on the grain rather than on the straw.

The grain weevil of Europe (*Calandra granaria*) has also been imported into this country, and has occasionally been very destructive. It has, however, been checked, and is not much dreaded now.

Kiln drying the wheat, or other grain attacked, is an effectual remedy. Another species of this weevil, differing but little from the above except in color, is found in the State of New York. It is black, and is said by Dr. Harris to be the *Calandra remotepunctata* of Schonherr. The larvæ of the grain moth (*Tinea granella*) are still more injurious to grain. Kiln drying and good ventilation, with frequent stirring of the heaps, will in a few years banish these pests from the granary.

4116 and 4117. All of our grains are more or less liable to rust and smut of the same description as that which appears in Great Britain. Even Indian corn is occasionally somewhat affected by a species of smut. It is seldom, however, so prevalent as to make any material difference in the crop.

With regard to the idea that barberry bushes cause smut or mildew, as alluded to in par. 4115, I have seen an instance noticed, where a farmer placed a barberry bush in the centre of his field of wheat. It flourished luxuriantly, as did the wheat in its immediate vicinity; the heads of wheat even grew up through the bush, without being in any degree affected.

4148. The remarks in this and succeeding paragraphs, relative to the summer culture of potatoes, and to the various remedies, or supposed remedies, against disease, are well worthy of attention, as are also the top dressings mentioned in par. 4152. The increase of crop caused by taking off the blossoms is,

I suppose, to be attributed to the natural tendency of every plant to grow until it has produced and ripened its seed. During the period in which this is retarded by artificial means, the tubes continue to increase, and the tops, which would otherwise have withered, remain green to the close of the season, as mentioned by Prof. Johnston in par. 4154.

The potatoe vine is attacked by a variety of enemies. One of the chief is the large green caterpillar of a Sphinx moth (*Sphinx quinquemaculatus*). This caterpillar is also found on the vine of the tomato. The three lined leaf beetle (*Crioceris trilineata*) preys upon the potatoe vine. It appears in June, and sometimes destroys nearly all of the leaves.

Cucumbers, melons, and squashes, are exceedingly infested by the striped bug, or cucumber bug (*Galeruca vittata*), a small yellow insect, with a black head, and a black stripe on each wing cover. A great number of applications upon the leaves have been recommended; plaster of Paris, sulphur, Scotch snuff, powdered soot, &c., &c. The only effectual preservative seems to be, to surround the young plants with a light wooden frame, having millinet or gauze stretched across its top.

Indian corn generally enjoys a remarkable exemption from the attacks of insects. Its chief enemy is the cut worm, belonging to some moth of the family *Agrotididae*. This worm destroys the young plant when it is yet but a few inches in height. It has the same habits as those of the same family in Europe. When going over a field of corn in the morning, drooping stalks betray where the enemy has been, and he may always be found within a few inches, either just under the surface, or secreted beneath a small stone or stick. By following up a careful search of this kind for a week or two, without intermission, this worm may be effectually checked, if not exterminated. A seed should be dropped wherever a shoot has been destroyed, unless there are already enough left in the hill. Other varieties of the cut worm attack cabbages, tomatoes, &c.

I have already mentioned Dr. Harris, of Harvard College, and cannot leave the subject of insects without again expressing my appreciation of his labors in this field. Mr. E. C. Herrick, of Yale College, and Dr. Fitch, of New York, have also been eminent observers; and, my information in this department is chiefly drawn from the writings of these three gentlemen.

4164. On Summer Fallows. Soils which are too stiff for the successful cultivation of green crops are comparatively rare in this country. We much more frequently find those that are rather light for this purpose. With these soils the difficulty generally lies not only in their physical state, but also in a

real scarcity of vegetable matter. Summer fallowing of such soils would clearly be injurious, as it would tend to lessen the already too small amount of organic matter which they possess.

The stiffest soils are therefore, as Mr. Stephens observes, most proper for naked fallows; but even on these, as I conceive, they should only be employed when green crops fail. There are, of course, exceptions to this remark; as, for instance, when it is desired to banish some troublesome weed that cannot be extirpated by any ordinary means. It is not customary, however, to follow up the business with such perseverance and energy as is recommended by Mr. Stephens.

Picking off the weeds by hand would in most cases be too expensive, but they might always be raked together, and carried to the compost heap. Many farmers fail to obtain the best possible effect of a naked fallow owing to a lack of perseverance. They commence well in the early part of the season, and go through the first ploughing with zeal and promptitude. But after harvest begins they are hard pushed with other work, and find it difficult to do more than keep the growing crops clean. The consequence is, that in the autumn a heavy crop of weeds often finds time to deposit its seed, rendering useless the labor performed in the early part of the season.

Of the clod crushers mentioned here little is known in this country. On stiff soils they would doubtless be found valuable.

Spade husbandry, as yet rare in England and Scotland, may be considered as unknown among us. The expense of labor, and the low price of land, render it inadmissible at present, excepting perhaps in market gardens, and farms very near to cities. It is without question more perfect than any other method of pulverizing the soil to a uniform depth, and its results cannot fail to be beneficial in all situations where it will pay.

4191. On the making of Butter and Cheese. In this branch of agricultural operations there has probably been a greater improvement within the last few years than in almost any other. There is no doubt that a superior quality of stock has had some influence, but still more has been done by animated competition, and by the steadily increasing demand for a really good article. We can now show butter in our principal markets, and at many of our county fairs, that will compare advantageously with the very best foreign samples.

As to methods of manufacture, their enumeration would involve the favorite and most approved modes of England, Ireland, Scotland, Holland, Germany, and all the civilized nations of Europe; for their representatives are all here, and in most cases preserve, for a

time at least, their old habitudes in every pursuit. There are, however, some points connected with the making of butter and cheese in this country to which it may be well to advert, in connexion with the remarks of Mr. Stephens upon this subject.

4192. The situation of the milk-room is a matter of much importance. When a sufficient circulation of air can be obtained to prevent mould, basement rooms are preferable, as there is less difficulty in keeping them at an equable temperature. In many places where the situation admits, a spring is made to run through such a room, furnishing at the same time means of cleanliness and of regulating the temperature.

We have accounts of processes, and samples of manufacture, from many dairies, which show unsurpassed skill, and there are large districts where the butter has long been noted for its excellence. Dutchess Co. in New York is one instance, and the neighborhood of Philadelphia another. It has been said that the pastures and the soil are of peculiar excellence in these localities, and they very probably may have some influence. That they are not paramount, however, is proved by the fact that butter is now made of equally fine quality in other counties, and sold as Dutchess Co. butter, for the sake of the name. Pastures may be enriched and improved by sowing grasses calculated to communicate a pleasant odor and taste to the butter: the sweet-scented vernal grass (*anthoxanthum odoratum*) is one that has been mentioned as valuable for this purpose. To the abundance of it in the neighborhood of Philadelphia, much of the fine quality of their butter has been ascribed. But it must be remembered that the best pastures and the best milk-rooms in the world will not compensate for a want of skill, or for carelessness in the making of the butter.

4194. Among all of the milk dishes mentioned and figured here, nothing is said of our tin pans—the lightest, cheapest, and, on the whole, the best, that could have been enumerated in the list. They are not easily broken or bent, are very readily cleaned, and are not acted upon if the milk sours. I do not see any particular advantage in the fixed coolers, par. 4200. They would be very expensive, and cannot be managed with so much facility as movable receptacles.

4201. Zinc is evidently an improper material for this purpose, as the most fatal consequences might result from its use.

4205. We accomplish this operation more conveniently by a strainer on one side of the milk pail, through which the milk is poured into the pans.

4206. Here again we have an advantage, as I think, in the employment of a tin skimmer in place of earthenware. It has

a convenient handle, and is not broken by a fall.

4212. The variety of churns that have been invented and put in use among us is almost endless, and even a list of their names would occupy several pages. In principle they, for the most part, resemble one or another of the four kinds here described by Mr. Stephens. Some of the later kinds, by a peculiar construction of the dasher, mix atmospheric air very thoroughly with the milk or cream, and thus separate the butter in a few minutes. It remains to be proved that as good an article is produced by such speedy churning, as by the slower old-fashioned way. See paragraphs 4222 and 4223.

4221. One point in which a great number of our butter dairies fail, is a want of thorough and efficient working when making the butter. For lack of this it is not firm and solid, but incloses numerous small globules of buttermilk. This buttermilk always contains casein or cheesy matter, which soon decomposes when it comes in contact with the air. Lactic acid is almost immediately formed; this acts upon the sugar of the milk and the oily fat of the butter, gradually promoting the formation of butyric, and capric or caproic acids; these are the substances to which the offensive taste and smell of rancid butter are owing. The more completely, then, that the butter is freed from milk, the better its quality, and the more ease in keeping it good. The testimony of Mr. Stephens, relative to the use of cold water in washing the butter, agrees with that of the best dairies in this country. Water can dissolve nothing from the butter that ought to remain there, and should be used till it comes off colorless.

4227. Much of our butter is greatly deteriorated in its value by the use of impure salt in its manufacture. The Liverpool blown salt, and that from Salina and Syracuse, is often contaminated by the presence of chlorides of magnesium and calcium. These prevent the butter from keeping well, and impart a bad taste. Some experienced dealers have said that much of the western butter is injured in this way, to the extent of six or seven cents per pound. Such salt may be purified in a great degree by the process mentioned in this column, but it is better to obtain a pure article at first, if possible.

Firkins, tubs, or casks, of wood, are used for packing in preference to earthen jars, probably because they bear transportation better. Sizes not to contain more than from 30 lbs. to 60 lbs. are more salable than the larger ones.

The precautions enjoined by Mr. Stephens in paragraphs 4229 and 4230 should be rigidly observed in packing butter. Great care must be taken in the selection of tubs, or all vessels of wood for packing. It is necessary that

they be well seasoned, and made of wood not liable to communicate a bad taste to the butter. White oak is usually preferred, as less objectionable in these respects than almost any other kind. When butter is intended to be sent on long voyages, or into a hot climate, it is recommended to pack small wooden firkins, containing from 20 lbs. to 30 lbs. each, into a tight hogshead, and then to fill up the hogshead with strong brine. In this situation the butter will remain unaltered for a great length of time. Packing the firkins in the same way, and filling in with dry coarse salt in place of brine, has been also tried with good success.

4231. In the article of cheese, the American farmers have improved so much within a few years that they are now able to compete in the English market with some of their best dairies. The dryness of this climate is highly advantageous in curing cheese, and in the west pasture scarcely costs anything. We have every facility, then, for this branch of productive agriculture; all that we need is experience and care in making. For want of these requisites, whole shiploads of cheese have been sent across the Atlantic, which turned out so poor as scarcely to repay the expense of freight. Notwithstanding all the information that has been so widely spread, such things still occur in every year. I would therefore advise all to study attentively the account of cheese-making here given—an account derived from some of the most reliable sources. No one can read it over without at least obtaining many useful hints.

4232. The temperature for curdling milk, mentioned by most of the best authorities, is from 90 to 95 degrees of Fahrenheit, and from want of attention to this point results a large portion of our poor cheese. Any person can perceive the effect of warming in coagulating milk. If a little vinegar or muriatic acid be added to sweet milk when quite cold, little perceptible effect will be produced for a considerable lapse of time; but if another portion of the same milk is gently heated, and then a small quantity of either acid added, the milk will instantaneously curdle, and become quite thick, so that it can be poured out in large clots. I cannot agree with Mr. Stephens that the finger is the best test in ascertaining the heat of milk that is to be curdled. However dexterous a person may become in this way by practice, the best will occasionally fail; but if a thermometer be at hand, the most inexperienced can regulate the matter with perfect ease and positive certainty.

The curd breaker, Fig. 379, is a useful little implement, and might be generally introduced in this country with advantage. It is just at this stage that a large part of our cheeses are irreparably injured, from want of

due care in pressing out the whey, and separating as thoroughly as possible the last remnants of it from the curd. A great variety of evils result where any considerable quantity of whey is thus left. The cheese often becomes full of little holes, and has a strong, sharp, disagreeable taste; it is also extremely liable to swell and crack. In the hold of a ship it is almost sure to spoil. Impure salt does harm in cheese as well as in butter; it is also said to cause swelling and cracking. In some kinds of cheese it is purposely introduced to communicate a certain peculiar flavor.

The cheese press, Fig. 381, seems to me a very clumsy, old-fashioned affair; and Fig. 382 is rather more complicated than necessary. We have numerous presses exhibited each year, that appear to be cheaper, simpler, and equally effective. Some of the self-acting presses are extremely ingenious, and are found to be both convenient and powerful in real practice. One or two kinds, in which the cheese presses itself by its own weight, are said to work very well.

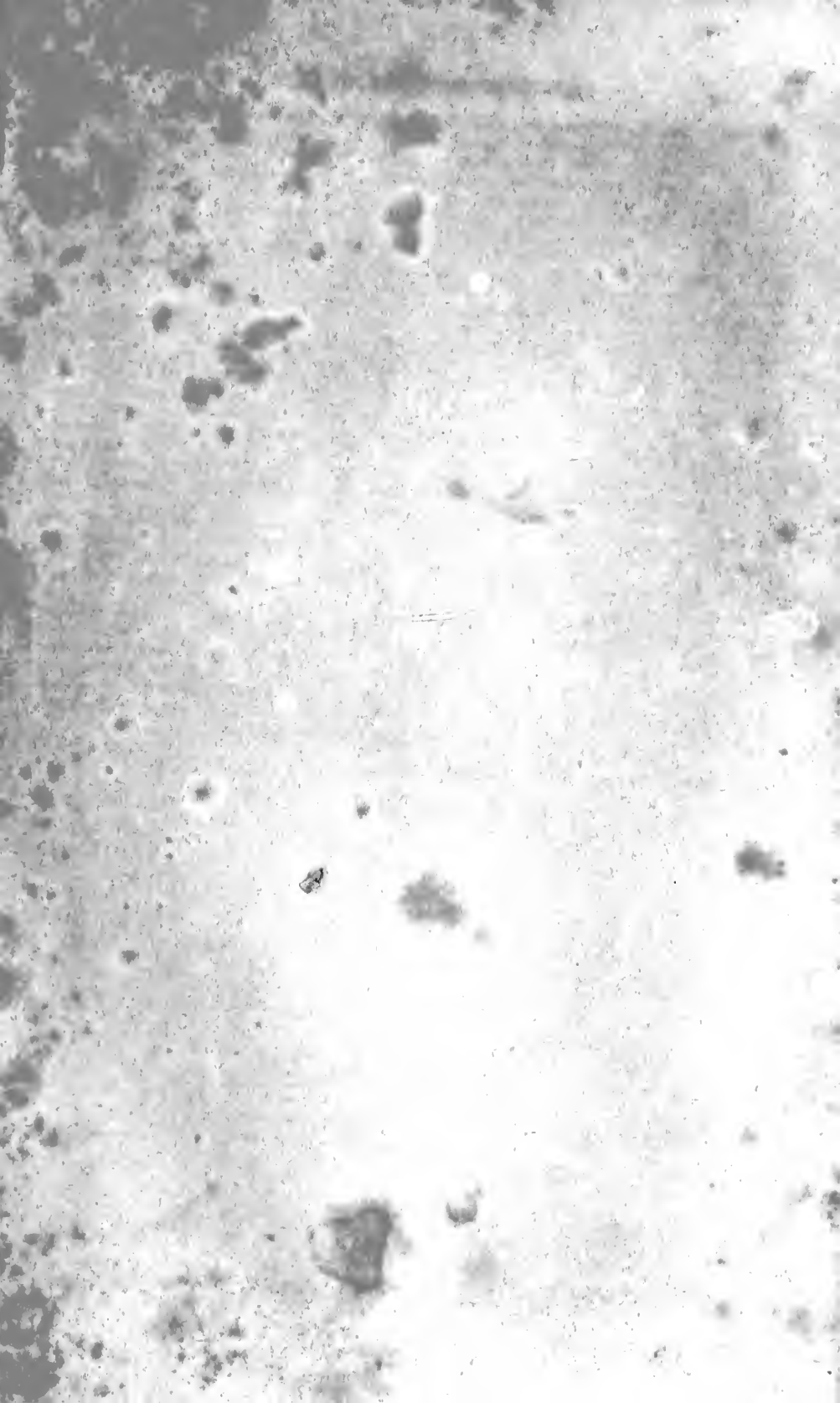
4246. The cheese turner, Fig. 383, seems to be a valuable and labor-saving invention, where cheeses of small and medium sizes are made; but where, as in many of our dairies, the cheeses range from 60 lbs. to 120 lbs. each, the frame would require to be of great strength and firmness, or the whole load would be lost in the operation of turning. It is evident, from the dimensions of the racks here given, and the number of cheeses that each is calculated to hold, that the weight of the individual cheeses must be small.

4256. I might collect without difficulty instances of great productiveness in milk, fully equal to those mentioned here; at the same time, it must be acknowledged that the yield of most dairies falls short of the best English and Scotch dairies. The remarks in par. 4260, as to the effect of different kinds of food in producing milk better adapted to make butter, and of other kinds in giving a milk richer in the materials for cheese, are well worthy of attention.

4269. The instrument here mentioned, the galactometer, is not by any means accurate, for the reason mentioned in par. 4267. Cream will not rise well through any considerable depth of milk, and there must be such a depth in the tubes of the galactometer, or there will not be enough cream obtained to measure at all. It is plain, then, that though useful for comparative trials, the depth in these tubes does not indicate the full richness of the milk.

4296. The cheese fly (*Piophilæ casei*) is unfortunately quite abundant in this country, and all cheese not well protected during the summer months, will soon present a fine collection of its maggots.

I shall not interfere with the pleasing ideas which Mr. Stephens seems to have entertained while penning the closing paragraphs of summer, nor presume to offer any suggestions by way of improvement to the dishes which are so evidently the result of thorough practical investigation.





THE GREAT BRITISH HORSE

THE PROPERTY OF MESSRS. JOHN & CO. EDINBURGH

1854

and other late-blowing plants, with their companions the fungi and mushrooms, which is a remarkable class of vegetable productions. "A large volume might be written upon the qualities and uses of fungi," remarks Dr Lindley. "They may be said to be important either as food or as poison, or as parasites destructive to the plants upon which they grow. As food, the most valuable are the *Agaricus campestris*, or common mushroom, the various species of *Helvella* or morel, and *Tuber* or truffle; but a considerable number of other kinds are used as food, in various parts of the world. About half-a-dozen species are only eaten in London; and in Paris none are permitted to appear in the markets except the common truffle, morel, and mushroom, the latter being cultivated to a very considerable extent in the ancient quarries which run under parts of the city. It is necessary to exercise the utmost care in employing fungi, the nature of which is not perfectly well understood, in consequence of the resemblance of poisonous and wholesome species, and the dreadful effects that have followed their incautious use. It is universally known that the common mushroom is cultivated with as much certainty by good gardeners as any other vegetable. The excellent *Boletus edulis* has been partially cultivated in the south of France. The common truffle has been attempted with more or less success. *Polyperus fomentarius* has been artificially produced in Germany, and five or six crops have been obtained in a year. A curious parasitical species, *Cyttaria Darwinii*, forms the principal part of the food of the natives of Terra del Fuego, during many months of the year. Fungi are much used in Australia by the natives, especially of the genus *Boletus*. The large truffle, *Mylitta Australis*, (Berkeley,) which attains a weight of more than 2 lb., is known under the name of native bread. The marsupial animals are particularly fond of fungi, and some species they hunt for so greedily, devouring them before they burst through the earth, that it is very difficult to procure a well-grown specimen."*

4344. "Poisoning by mushrooms," observes Dr Taylor, "is by no means unusual

as the result of accident. It is a curious fact, that the poisonous properties of mushrooms vary with climate, and probably with the season of the year at which they are gathered. Another circumstance deserving of notice is, that, by idiosyncrasy, some individuals are liable to be seriously affected even by those species which are commonly regarded as innocent. There do not appear to be any satisfactory rules for distinguishing the mushrooms which are wholesome from those which are poisonous. The best test is that assigned by Dr Christison, namely, that the poisonous vegetable has an astringent styptic taste; and perhaps also a disagreeable, but certainly a pungent odour. All mushrooms that are highly coloured, or grow in dark or shady places, are generally poisonous.

4345. "Ketchup, a liquor made from mushrooms, has occasioned faintness, nausea, and severe pain in the abdomen, disappearing only after some hours. There are two ways of explaining this effect—either that the individual labours under idiosyncrasy with respect to mushrooms in general; or that noxious fungi have been gathered, by mistake, for esculent mushrooms. The poisonous principle contained in mushrooms is called *fungin*: it appears to be of a volatile nature, and soluble in water; for some varieties of noxious mushrooms may be eaten with impunity, when they have been well boiled in water and afterwards pressed,"† or pickled in salt and vinegar.

4346. It is in autumn that irregularities in the functions of the digestive organs—such as cholera, diarrhoea—happen, besides the many diseases that in tropical climates accompany particular winds or weather. It is difficult, in certain states of the atmosphere, to regulate the bowels, either by medicine, diet, or exercise, so as to effect the desired changes in the animal economy. It is possible there may be different states of atmosphere which act as specific stimuli, and produce their corresponding peculiar, diseased, nervous actions, which are further varied by the particular state of constitution, and other circumstances of the patient. There seems no

* Lindley's *Vegetable Kingdom*, p. 37-9.
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† Taylor *On Poisons*, p. 768.

other way of explaining either the recurrence of the cholera in this country, from 1832 to 1849, or of its decided effects in one locality more than in another.

4347. There are four proverbs extant, connected with the months of autumn:—

Dry August and warm, doth harvest no harm.
 If the twenty-fourth of August be fair and clear,
 Then hope for a prosperous autumn that year.
 September, blow soft, till the fruit's in the loft.
 Good October, a good blast,
 To blow the hog, acorn and mast.

4348. Of meteorological antiquities, "the feast of St Peter *ad vincula*, or Lammas day, 1st August, is said to have been the first of the Egyptian year; and old legends relate certain cures of disorders in the throat, made this day, by touching the chains of the saint. On the assumption of the Virgin Mary, August 15th, it was formerly the custom to implore a blessing upon herbs and plants of diverse kinds, which, being afterwards burned, were esteemed a charm against witches. The 16th of August, dedicated to St Roch, was celebrated as a harvest home, a practice still kept up in many countries. The quantity of knives given away at Croyland Abbey, on St Bartholomew's day, 24th of August, as noticed by Mr Richard Gough, originated probably in the story of the knife with which the apostle was flayed alive. The feast of the exaltation of the Holy Cross, September 14, can have no other connexion with the growth of nuts in the hedges, than that it is celebrated at a time of the year when they abound; yet an ancient custom prevailed of going a-nutting on holy-rood day, which it was esteemed quite unlucky to omit. The particular time of the year when nuts may be ripe has probably suggested this notion; as also the flinging of apples and cabbages at one another, a custom practised at Kilderminster—a ceremony to commence which the bell in the turret of the town-house used to be rung. The 29th of September is the feast of St Michael and all Angels. Many customs remain in force on this day, as the eating of green geese; the procession in the isle

of Skye; the breaking of the bannock, and the firing of a *feu-de-joie* in honour of the vanquisher of Lucifer and his host, by St Michael and his angels—an emblem of which, in the vane, surmounts the steeple of the town-house of Brussels."*

4349. An atmospherical delusion, occasioned by a cloud common in autumn, the *stratus*, is recorded as having happened some years ago at Florence. A stratus of shallow depth, but very intense where it prevailed, intercepted the view of the dome of one of the churches from the spectators in the streets, while the gilded image at the top was left exposed to view. The consequence was, that the populace, seeing the bright form of an *angel* through the mist, which just then began to be thin enough to admit of the image being seen, ascribed the appearance to the real descent of some celestial being. Had the fog continued till night, there is no saying what new miracle might not have been recorded, as the testimony to the phenomenon was both numerous and respectable.

4350. Mean of the atmospherical phenomena of autumn are as follows:—

Mean of the barometer in England in—	
August, .	28·91 inches.
September, .	29·92 ..
October, .	29·92 ..

Mean of autumn, 29·58

Mean of the thermometer in England, in—	
August, .	62°·20
September, .	56°·87
October, .	50°·55

Mean of autumn, 56°·54

Tension of vapour for 56°·54 = 22·09.

Mean fall of rain in England, in—	
August, .	2·06 inches.
September, .	2·67 ..
October, .	2·28 ..

Mean of autumn, 2·34

Prevailing winds in England, in—	
August, .	S.W. to N.W.
September, .	N.W. by S.W. to S.
October, .	W. by S.E. to N.E.†

The number of storms in the west of Europe, in autumn, is 20·9 in 100.

The number of hail-storms in England, in autumn, is 22 in 100.

* Forster's *Researches into Atmospherical Phenomena*, p. 299.

† Whistlecraft's *Climate of England*, p. 54-222.

Aurora borealis observed in—

August,	217 times.
September,	405 "
October,	497 "

There are two maxima of aurora borealis, one in March, another in October.

Number of fire-balls seen in—

August,	69
September,	51
October,	61

In August, when shooting-stars are common, then are also many fire-balls.

4351. The great event of autumn is the harvest, which engrosses the entire time and attention of the farmer and all his assistants, until the crop is secured beyond danger in the stack-yard; and until it is secured, the farmer cannot rest in quietness. During this eventful period, the farmer ought to look about him night and day, regarding the "face of the sky," and to act with circumspection. The results of the whole year of labour being at stake, unless he feels that he has applied his utmost skill, and exercised his best judgment, during the year, he cannot be satisfied with himself. None can more anxiously than the farmer follow this advice:—

The wind, the rain, the sun,
 Their genial task have done,
 Wouldst thou be fed,
 Man, to thy labour bow,
 Thrust in thy sickle now,
 Reap where thou once didst plough,
 God sends thee bread.

JAMES MONTGOMERY.

When every straw is safe in the stack-yard, and he has closed the stack-yard gate for the season, then, and not till then, ought the farmer to be satisfied that his task is finished, and that he may now enjoy repose. The labour of harvesting a crop is almost incredible. Only conceive the entire farinaceous food of such a nation as this, in value worth a hundred millions, reaped and carried into safety, in minute portions, in the course of a single month!

4352. Besides the harvest of the cereal plants, that of the leguminous, as well of all the root crops, takes place in autumn; for although the turnips are not wholly removed from the ground at one time, like the other crops, they are begun to be so in autumn.

4353. Some curious anomalies in farm labour occur in autumn. One is found

in the sowing of a new crop of wheat, while the old crop of the same grain is in the act of being reaped; and another is, that while the spring is the natural season of preparing for the reproduction of most of the animals of the farm, the autumn is the one for the preparation of the reproduction of the sheep, the most valuable animal of all, when the tup is put amongst the ewes.

4354. A tendency to disease seems to exist in autumn in the animals of the farm: sheep are liable to hepatitis; calves to quarter-ill; the horse to colic, and even inflammation of the bowels; and stallions and geldings lose their spirit. Perhaps the nutritiousness of the aftermath—excess of nitrogen—on which all the animals subsist in autumn, may predispose the animal system to secrete one class of fluids, and thereby induce particular complaints in the others. If this be the true theory, preventive measures should be sought for and obtained; and oil-cake seems to possess a counteracting property. A preventive remedy against annoyance to sheep from parasitic insects, and cold, is bathing and smearing.

4355. The sports of the field commence in August. The gatherings on the hills on the famed 12th of August, in quest of the unique-flavoured red grouse, *Lagopus Scoticus*—of which Scotland should be proud as its only indigene—find a home in shielings, which, at other seasons, in the enjoyment of urban luxuries, would be contemned. Partridge-shooting follows in September, sometimes even before the corn is cut down—hare-hunting finds ample room by October—and, last of all, the attractive "music" of the pack gather around it, from hill and dale, all the active Nimrods of the country.

4356. In taking a retrospect of the seasons, we have passed in review, we must own that our climate is far from being genial. The frequent changes to which the weather is daily susceptible, render the cultivation of the soil always a difficult, and not unfrequently a vexatious, occupation. Such vicissitudes, no doubt, sharpen the intellect of the farmer, and the stimulus imparted by them, perhaps, has been the chief means of eliciting the

high skill which is generally acknowledged to be apparent in the agriculture of this kingdom. Skill will always be so stimulated in our insular position, which subjects our atmosphere to be perpetually acted upon by the heat of the adjoining continent, and the moisture of the surrounding ocean. Placed thus in a fretful climate, no wonder the farmer would rather have one of equanimity, so that he is sometimes tempted to envy the bright skies which illumine the Continent. Would he wish always to enjoy a beneficent climate, let him take this advice,—“ If any one has, as I have, a horror of icicles, and who would never have the mild temperature of the air interrupted by the presence of a hoar-frost, let him migrate with the climate. Let him spend the month of January in Portugal; February in the Madeiras; March in Spain; April in Sicily; May in Lapland; June in Italy; July in Switzerland; August in France; September in England; October among the forests of America; November in Crete; and December in the islands of the Cape de Verd. By this rotatory motion he may enjoy a delicious temperature, and revel in honeysuckles and roses all the year round.”* But the occupation of a farmer does not admit of his flitting so much about as is here recommended, so he must content himself with the climate, in whatever locality his lot is cast.

4357. Before attending to the practical operations of autumn, I should premise that several crops sown in this season are not only treated in a way different in England from what they can be in Scotland, but some of them cannot be sown in Scotland at that period with impunity. Most of the forage plants sown in autumn in England, for the purpose of affording early food in the following spring, as crimson clover, winter tares, cannot be sown at that season in Scotland, because they cannot withstand a Scottish winter; and several plants which may be sown with impunity in England, on the stubble ground, after the removal of the white crop, as the stone turnip and rape, cannot with impunity be sown so late in the season in Scotland. The harvest in England being about three weeks earlier, the stubble is not only bare so much earlier, but the

land is then in a comparatively drier state, and may be worked to advantage before the arrival of the bad weather usually experienced in the latter part of autumn. The later harvest in Scotland, and the earlier arrival of winter weather, will not permit the immediate cropping of the stubble after a grain crop; and I am not sure that, even if time did permit the soil to be put into a proper state for a crop, any crop would be taken; for, according to the rotation usually followed in Scotland, the only stubble ground available in autumn for a succeeding crop is that of the oat, which terminates the rotation, and which presents the land in the foulest state it is in before it is fallowed. The other stubbles are occupied with new grass, and are not available for another crop. Now, in England the circumstances are different; for, independently of an earlier harvest and a stubble sooner cleared, most of the stubble land is bare, not occupied with new grass, little new grass being sown amongst the white crops, on account of the large extent of old grass on most farms. The stubble therefore of a white crop, which had been taken after a fallow crop, is quite in a state of freshness and cleanliness for a forage crop; and since the climate offers no injury to such a crop in winter, the very natural desire to have a forage one that will cut early next year, may be gratified with certainty. And were the practice of autumn culture confined to the stubble of the land in fresh condition, there could no valid objection be urged against it; but when the practice is pursued on the stubble, which exhausts the rotation and the soil at one and the same time, it is highly objectionable: it renders any autumn crop so taken a catch crop; it exhausts the land beyond its strength, and renders it foul with weeds to a shameful degree. But in ordinary circumstances all autumnal crops render the land foul, there not being sufficient time to work it after harvest, before the succeeding crop should be sown; and also want of time in spring, after the autumnal crop is removed, to clean the land for the summer green crops. That the land is rendered foul by such a practice may be adduced from the objection raised to sowing the artificial grasses among the grow-

* *Note-Book of an Ozonian—John Bull, 5th August 1843.*

ing white crops, for the reason that they would prevent the hoeing of those crops in summer, whereas the land ought to be so clean, as all the weeds in it should injure neither the growing crop nor the new grasses; and it would be so clean, but for the practice of taking catch crops in autumn; and it is actually so clean under the Scottish practice. It must be owned, however, that the attainment of a forage crop that will cut early in the season is a desideratum in Scotland; and I cannot see that it is to be obtained, in the circumstances of that country, but by the entire abandonment of bare fallowing, and the appropriation of a portion of the fallow-break to well-matured autumnal crops. It is in this way that I propose describing the culture of the autumnal crops for use in the succeeding spring, making reference at the same time to the practice of England by which those crops are usually raised.

ON THE SOWING OF THE STONE TURNIP, AND
ON THE SOWING OF TURNIP FOR SEED.

4358. The stone turnip, both yellow and white, is raised in gardens for use in winter. It is a turnip of an oblate spheroid in shape, and having a small neck at the shaw, and a small filamentous tap-root. For particular reasons, the white variety of stone turnip may be successfully raised in the field; and the reasons are—that when the state of the weather, or of the land, has prevented as much ordinary white turnip being sown in time as was desired, it is prudent to relinquish the farther sowing of it until the time arrive for sowing the stone turnip, which, sown in the early part of August, will attain maturity and a good size by October. Or, when some early turnips are wanted, the stone turnip may be sown before the time for any of the field turnips.

4359. The English practice is to sow the stone turnip on the stubble land after a white crop; and there being but little time to work the land aright, and the crop being sown broadcast, it does not grow larger in that country in the field than it does in the garden. All the culture the land usually receives is a shaving off the stubble with the skim-plough, fig. 240; and after a grubbing, fig. 215, the seed is

sown broadcast. No species of turnip will attain a large size with such culture, nor can the soil afterwards be otherwise than foul.

4360. The stone turnip in autumn is cultivated in every respect as the common turnip, as regards the working of the land, its manuring, the sowing of the seed, and the after culture, both manual and implemental, as described from (3204 to 3282,) and need not be repeated here.

4361. Turnips intended for seed are sown in the drill in autumn, as well as transplanted by the bulb in spring, described from (2476 to 2483.) The culture, up to the singling of the plants, is the same as that of the common turnip from (3204 to 3260;) and where the land is dry below by drainage, natural or artificial, it requires no further work all winter; but where the subsoil is still retentive, it is expedient to set up the drills a little with the double mould-board plough, fig. 209.

4362. I much prefer raising turnip seed by transplantation of the bulbs to sowing the seed, because it is a method more certain of raising pure seed, though it sacrifices a portion of the crop of turnips, and is attended with some trouble. It is true that spurious plants may be easily distinguished by their flower when the crop is in blossom, and pulled out, but the soil in the mean time has been employed in growing spurious plants to its disadvantage; and although there should be but few of these, there will be many genuine ones of weak constitution, which will produce weak seed. Judiciously selected bulbs, on the other hand, will produce stout, equal-sized plants, and large and healthy seed. It is also true that bulbs cannot be transplanted over many acres, without sacrificing a large proportion of the crop that should be consumed; but the comparatively large return of seed received from transplanted bulbs will probably remunerate both for the sacrifice of the crop, and the additional trouble incurred in transplanting them. If this point has not been already ascertained, it should be made the subject of experimental inquiry. But even with the precaution of pulling out the spurious blossoms, many of the plants left to grow may produce seed which will grow thick-necked turnips; and I quite agree with

Mr S. Trewecke of Breage, Cornwall, as regards the raising of turnip-seed, when he observes, "I have found, from several years' experience, that the better the quality of the turnip the less is the quantity of the seed, and the worse it is to bring to maturity; while with the stringy, spongy, long necks and bushy roots, a large quantity of seed may be saved with little trouble. I think farmers in general pay too little attention to the quality of the seed, if they can get a cheap article, or grow a large crop.*"

4363. By much the largest proportion of the turnip seed raised in Scotland is so from the seed, and not from transplanted bulbs; which being the case, we may doubt the genuineness and strength of the vitality of the seed so grown; and, for all the seed the most extensive grower of turnips requires, it is in his power to raise as much as will supply his own wants from transplanted bulbs in a comparatively small space of ground. The crop sown from the seed in autumn will not mature its seed before the one transplanted from the bulb in spring.

ON THE SOWING OF WINTER TARES.

4364. When tares are sown in autumn, to stand the winter, care should be taken to procure the proper seed; there being two sorts of tares in the market, one called the *winter tare*, which should only be sown in autumn, and the other the *spring tare*, which would be destroyed in winter were it sown in autumn. No such botanical distinctions exist between the plants as to constitute a distinct species, the winter tare being only known by its smaller growth, and its seed-pods being more smooth and cylindrical. Little difference is observable in the seeds, the winter variety being small and of uniform size; the spring varies in size, which characteristic has obtained for it the appellation of *vetches*, while the smaller kind is called *tares*. The difference of habit in the plants has arisen entirely from the circumstance of their having been continued for years to be sown in winter and spring respectively.

4365. The usual cultivation given to

winter tares in England is one furrow from the stubble; but if there is time between harvest and winter, and the weather at all favourable to field-work, the land should receive more labour than a single furrow, in justice both to itself and the crop. The stubble should at once be cross-ploughed, (2613) then harrowed, and then gathered up into ridges (749) before the seed is sown on it. The winter tare is usually sown without dung, and on rich kindly clays the crop will be good without its assistance; but land in poor condition, and naturally light soils, should be manured. When there is only time to give one furrow in autumn, the dung should be applied on the stubble; but with two furrows, it should be applied in the second ploughing, when the land is ridged up. The reason for preferring the second ploughing in manuring the land is sufficiently obvious, since the second ploughing in ridging up would bring to the surface the unrotted dung ploughed down in the first ploughing.

4366. Where the tare stands the winter well, it may be sown alone, with from 2 to 2½ bushels of seed to the imperial acre, according to the condition of the soil; but a little wheat amongst it will not only protect it from frost, but serve to augment the amount of forage in spring. For this purpose half a bushel of wheat will serve. Rye is very commonly sown among winter tares, but the wheat plant will support the tare plants better, while its habit of growth is more consonant with that of winter tares, as the rye will outgrow the tares in spring. Wheat is not pleasant to stock as a forage plant (2468,) but in this case it will be better than overshot rye, and oats do not stand the winter. You may err in sowing tares too thick, which they are when the stems grow small, and the roots are crowded on the ground, in which case the plants will rot off in damp weather, especially on naturally or artificially made rich soils. If the weather and land are sufficiently dry in early spring to allow a light roller, fig. 222, to pass over the young tares and wheat, the ground will be much improved for the cutting of the crop by the scythe; but if the rolling cannot be then done, the crop will have to be cut in spring on the rough ground by

* *Mark Lane Express*, July 1841.

hand with the sickle, as it would be improper to roll the ground immediately before winter. Should the tares be sown early in autumn, the ground may be rolled immediately after being sown.

4367. In well-sheltered good soil, tares will stand the winter in Scotland, where they prove very valuable forage in spring; in this generally, as in many other respects as regards climate, the English farmer has much the advantage of his Scottish brother. Winter tares should not be attempted to be raised in Scotland without manure, nor upon stubble ground, unless in a season when the harvest has been finished very early. It will be more safe to sow them on the dunged fallow-break, or on the land from which early potatoes have been lifted, and where wheat is not sown after potatoes.

4368. The autumn culture of tares is precisely the same as for summer, detailed from (2464 to 2469.) The crop has little chance to be affected by the slug in winter.

ON THE SOWING OF RAPE IN AUTUMN.

4369. Rape is cultivated in autumn, in England, on the stubble after a white crop without manure, and it thrives very well all winter, and gives an early forage in April or May. It will not endure such treatment in Scotland; the land must there be worked, manured, and sown in the same manner as for turnips, as detailed from (3204 to 3230.) Rape plants not being singled, the culture of the turnip, in regard to hand-hoeing and the use of horse implements, is not required for them. The summer culture of this plant has been detailed from (3448 to 3451,) and the crop thus raised is consumed in autumn. Its winter culture is not much attempted in Scotland, because turnips afford a more substantial and certain food for sheep, which are the only species of stock put on rape, it never being cut and brought to the steading to the cattle, though it might be consumed by the cows in spring, when probably its leaves would not impart so strong a taste, if any, to the milk and butter, as turnips are known to do. Dairy-

farmers might, therefore, cultivate winter rape, while no inducement exists for farmers who feed stock doing so. The rape is not affected by insects in winter, as is the case in summer (3454.)

ON THE SOWING OF CRIMSON CLOVER IN AUTUMN.

4370. The crimson clover, *Trifolium incarnatum*, (2676,) is one of the most beautiful plants cultivated in the fields, its stem rising to eighteen inches or two feet in height, with spikes of tapering, nodding, beautifully bright scarlet-coloured flowers. It has long been cultivated in the garden as a border annual, and has only found its way into the fields within these few years. It is an excellent forage plant, and, when sown in autumn, so quick is its growth that it affords the earliest cutting in spring of any plant sown at the same time. It has been very successfully cultivated in the south of England, and perhaps the chalk formation answers its nature best of any soil; but in Scotland its success is at least doubtful, even in the most favoured spots. I suspect that the climate of that country is too humid and cold for this plant.

4371. Of all known plants it is best suited for culture on the stubble of a white crop, an apparently favourite mode of culture in England for many plants. "There," observes Mr Lawson, "it has been found to succeed best, either drilled in summer in rows of from eight inches to one foot distant, or sown in autumn in broadcast on stubble, after the corn crop has been removed, and with no previous preparation save a harrowing or two, so that the seed may be the more easily covered. In very tenacious soils a very shallow ploughing is given, but in general it is found better to dispense with the ploughing altogether; for the many failures which occurred previous to its culture being properly understood, are now attributed entirely to the ground having been too much loosened and pulverised by repeated ploughings."⁴

4372. In England, from 18 lb. to 20 lb.

* Lawson's *Agriculturist's Manual*, p. 154.

of seed are sown on an acre, in broadcast; and when the crop is drilled, the quantity is increased or lessened according to the nature of the climate and soil. It ripens its seed easily in England, and English seed of the first year after importation is the best, being heavier and more free of the seeds of weeds than the foreign seed.

4373. When sown in autumn, the entire crop may be grown, cut down, and cleared off, by the June following, allowing the ground to be worked up for a late sowing of turnips, to be consumed in the following autumn. When cut in full flower, it makes a hay much relished by horses, and its entire yield is said to be more than the common clovers. It is better suited to sow on stubbles than even the stone turnip, (4358.) It is more rapid in its growth than winter tares, (4364.) On light land a crop of buck-wheat may be readily obtained after it, (3464.) Italian rye-grass may be sown with it, and will grow as rapidly, (2644;) and after the crimson clover has been cut, the rye-grass will continue to grow and afford an excellent second crop. The crimson clover has the property of smothering early weeds, on account of which property, it is not well suited for sowing among a corn crop.*

4374. A variety of the crimson clover, named *tardif*, or late-flowering, by the French, was introduced to notice in France about 1836. If sown immediately after the common variety in autumn, it will flower next season after that has yielded its crop, and thus form a valuable successor to it. Its characteristics are lateness of flowering and tallness, with vigour of growth. Mr Lawson says, that the late "Sir John Robison of Edinburgh had the merit of first introducing this variety to Scotland, having, in 1837, given a quantity of its seeds, as well as those of the common crimson and Moliner's clover, to the Highland and Agricultural Society of Scotland—the results of a comparative trial with which were, that the plants of this came into flower when those of the common were nearly over; and, on being

cut, its produce was nearly a third heavier than that of any other clover."†

4375. The crimson clover would be a great boon to Scotland as an early forage plant in early summer, were it rendered so hardy in its habit as to stand the winter and spring frosts. The subject is worthy of experimental investigation by farmers and agricultural societies. Perhaps the best way to obtain the object would be for the best English seed to be sown in Scotland—in some favoured locality at first—with the view of raising seed from the plants, and then to sow such seed in successive generations for a few years, until the plant becomes naturalised to the climate; after which it might stand the winter and grow as a forage plant.

4376. The pecuniary advantages attending the cultivation of the crimson clover are thus summed up for the acre by Mr Foaker:—

1 acre of food, cut green at £3,	£3 0 0
1 .. hay, 2½ tons, at £4 per ton,	4 0 0
1 .. seed, 12 bushels, at 40s. the bushel, }	24 0 0
3 loads of threshed haulm at 30s. }	4 10 0
	<hr/>
Value of 3 acres,	35 10 0
Deduct seed and labour on do.,	1 14 0
	<hr/>
Profit,	33 16 0
	<hr/>
Profit from one acre,	11 5 4†

ON THE SOWING BOKHARA CLOVER.

4377. Having raised the Bokhara clover, *Melilotus leucantha major*, for several years past, as an ornamental plant, and having found it to stand the winter and grow early in spring, I am induced to recommend it as a forage plant that may be sown early in autumn, and cut early in spring; and also sown in spring, in April or May, and ready to be cut in August, after the first cutting of the red clover is over, and before its second cutting, if there be any, is ready. If sown after early potatoes in Scotland, and upon early stubble in England at the end of August, the plant will, I think, be so far advanced as to stand the winter—at least it has done so with me; and although its herbage is

* Rham's Dictionary of the Farm—art. Clover.

† Lawson's Agriculturist's Manual—Supplement, p. 47.

‡ Foaker's Observations on the Cultivation of Scarlet Trefoil, p. 16.

cut down by the frost, its roots send up shoots early in April. It should be cut when young and succulent, for after it has attained the height of above two feet, the stems become fibrous, and harsh to the taste. The best way of sowing it is in rows of 9 inches apart, that the land may receive a hoeing in spring to loosen it about the roots for the admission of air. It is a plant that bears much moisture in the earlier stage of its growth, and is all the more succulent for it.

4378. When allowed to grow up, in the second year, the plant being a biennial, it sends up six or eight stems, which easily attain the height of seven to ten feet, and throw out side branches. It becomes covered with a profusion of small, neatly formed white flowers, having a scent not unlike that of the sweet scented vernal grass, *Anthoxanthum odoratum*, when made into hay; or of the woodroof, *Asperula odorata*, when dried;—the racemes growing on and appearing in succession from June, until the frost in November or December cuts them down. The honey bee is very fond of its flowers, and on that account, as well as for its own beauty and stateliness as a plant, it is deserving of a place in every farmer's and cottager's garden. It was introduced into this country in 1839, and at the time created a sensation from its luxuriant habit of growth.

ON THE SOWING OF RED CLOVER FOR SEED.

4379. Red clover seed, *Trifolium pratense*, as you have seen in (2633,) is not sown alone among the grain crops in Scotland, and cannot therefore be reserved for growing seed, though the climate would in some seasons allow it to be ripened. I have gathered its seeds in particular seasons as fine as any grown in England.

4380. In England, the rye-grass, *Lolium perenne*, is not in so great favour as a forage plant as in Scotland, so that crops of red clover without rye-grass are there more common than in the latter country, although not intended to bear seed. Where the red clover is raised for seed, the seed is sown without any admixture of white clover, *Trifolium repens*, or of rye-grass.

4381. The soil best suited for raising seed from the red clover is described in (2671;) as a forage plant the red clover is mentioned in (3886;) it now only remains to relate how it should be managed as a seed-bearing plant. Were it allowed to stand for seed, at the first cutting, when the blossoms do not appear simultaneously, the seed of one plant would be matured, while that of another would be scarcely formed. At the second cutting the flowers blossom all at once, and the plants all attain about the same height; and the crop then appears one of the richest description in our fields, in a favourable season. The second cutting of 1849 was a particularly fine one, and continued full until the early frost of October injured it. The first cutting in ordinary practice is delayed until the plant is in full bloom, and sometimes till after the bloom has begun to decay, so that no surprise need be excited when a full second cutting of clover is not obtained after such treatment. When the seed sown is imported direct from Holland or France, a full crop in the first cutting should only be expected, for a good second cutting from such seed is never obtained, as has been shown in (2671.) The loss of the second cutting may thus be accounted for in cases where foreign seed has been sown unknowingly by the farmer. To secure a good second cutting, the first crop should therefore be cut before the plant comes into bloom; or sheep in adequate numbers should eat down the crop by the end of May or beginning of June; and no foreign seed should be used. The second growth will then come away thick and with vigour.

4382. The red clover is injured by insects when in bloom. It is affected by a weevil named *Apion apricans*, in length about $1\frac{1}{2}$ line, the colour of the body being black. By the time the heads of the red clover are ready to flower, the apion deposits her eggs on the calyx of the florets. As soon as they are hatched, the larva, an extremely minute whitish worm, with a black head, eats its way through the base of the floret, and consumes the rudiments of the future seed. So extensive is the injury occasioned at times by this creature, that, in 1798, a crop of red clover covering $4\frac{1}{2}$ acres, producing $16\frac{3}{4}$ bushels of seed, was worth £41, 17s. 6d.; while the like

extent of ground in 1800, produced only $7\frac{1}{2}$ bushels, worth £18, 15s.; thus this little insect occasioned a loss of £23, 2s. 6d. on the produce of $4\frac{1}{2}$ acres of land. See (3894.)

4383. When the blooms of the plants become withered and brown, the crop should be cut down, which may be done either by the hand with the sickle, or with the scythe; and it may be expected to be cut down in the end of August or beginning of September. If put together in heaps on being cut, a slight degree of fermentation ensuing will cause the seed to leave the husk the more readily on being thrashed; and on the fermented heaps being spread out to the sun, the crop will soon be dry enough to lead home to the steading, to be thrashed with the flail or thrashing-machine. Should the weather be good, this plan may be adopted, but should it prove damp, the crop should be made into sheaves, and set into stooks to won, and afterwards carried to the stack-yard and built into stacks, to be thrashed at any convenient time.

4384. There is little danger of clover seed falling out from its husk, as it is rather difficult to thrash out; but the fermentation of the plant recommended above renders the husk brittle, and easily broken by any process of thrashing. Where a large quantity of clover is cultivated for seed, the thrashing-machine may be employed to take out the seed; but of a small quantity a considerable proportion might be lost in the mill, so the flail, fig. 350, should then be used. The fanners, fig. 149, will blow away the husky light matter, while the heavy seed is falling down the corn-spout, from which it should be sifted through the sieve, fig. 162, to free it of dust and sand and blind husks, and then measured into the bushel, fig. 168. Should the farmer raise clover seed only for his own use, he need not take the trouble to thrash the seed out of the husk, but sow it in the husk—which plan has been suggested to prevent land becoming clover-sick, (3890.)

4385. The importation of foreign clover seeds was thus in—

	1847.	1848.
Foreign clover seeds } imported	226,347	98,994 cwt.
Entered for home consumption, }	176,334	124,143 — (2661) and (2682.)

4386: The composition of the ash of clover seeds will be found in (3897.)

ON THE SOWING OF ITALIAN RYE-GRASS IN AUTUMN.

4387. In (2644) I gave it as my opinion, that Italian rye-grass, *Lolium Italicum*, growing rank and quick as it does, is not so well suited for sowing among a grain crop as by itself, when it is to be used as a forage crop. Its nature certainly indicates that it is much better adapted for a forage than a pasture plant. Viewing it in this light, it should be sown by itself in a portion of the dunged fallow land, in August or the middle of September at latest, that it may acquire sufficient strength to stand the winter. It may be sown broadcast, there being no use of drilling it, since it will grow as early in spring as any weed, and will outstrip it in growth. From its natural tendency to produce many stalks from the same root and its upright habit of growth, not forming a close turf, it should be sown thick, and particularly so when sown in autumn, to stand the winter. Three to four bushels of seed to the acre will therefore be required to have plants enough in spring for an early cutting. If the ground and weather are both dry in spring, the roller, fig. 222, should be passed over the crop to smoothen the surface. The crop will be ready for cutting in May, and may yield from three to five tons of forage to the acre.

4388. Mr Lawson says, that "the Italian rye-grass is synonymous with the *Lolium Bouckianum* of Kunth, who in his *Agrostographia* thus describes it: 'Spikelets about thrice as long as their glumes, and each containing five to ten awned florets; root perennial; native of Italy.' And farther, that 'this species differs from *Lolium perenne* in its florets being awned.' Like all other plants subjected to artificial culture, the Italian rye-grass is productive of numerous sub-varieties, as a proof of which we received, in 1838, specimens of no less than 50 distinct spikes, from Mr Robert Arthur, which he collected in a field near North Berwick. In this country, no attention has, however, as yet been devoted to the selection and cultivation of any variety possessing permanency and superiority of character." *

* Lawson's *Agriculturist's Manual—Supplement*, p. 37.

4389. The composition of the ash of the seed of the Italian rye-grass was given in (3897,) and the pounds of ash in one ton of the plant in flower is as follows, according to the analysis of Professor Way and Mr Ogston :—

	lb.
Potash,	17.2
Soda,	5.5
Chloride of sodium,	3.1
Lime,	13.8
Magnesia,	3.1
Peroxide of iron,	1.1
Phosphoric acid,	8.8
Sulphuric acid,	3.9
Silica,	81.7
	136.2

“The composition of the ash,” observes Professor Way, “is but little altered by the presence of the seed; probably, because it is small in quantity. It is seen that Italian rye-grass is, like other cereals, a *siliceous* plant; and indeed, in the quantity of silica it removes from the soil, it surpasses even wheat-straw, which contains about 60 lb. in every ton weight. When, therefore, the use of liquid manure is able to produce many successive luxuriant crops of this plant, there can be no want of available silica in the soil for any crops.”*

ON THE PICKING AND DRYING OF HOPS.

4390. We left the summer culture of the hop in (3183;) we have now to attend to the sowing of the crop, which usually commences in the first week of September.

4391. Hops when ready to be picked become close and firm, and the seed hard and brown on the outside, with a general appearance of ripeness.

4392. Before picking commences, the bines are cut over at 3 feet from the ground, and the poles raised out of the ground by means of a lever, and laid upon their side in a convenient place and position upon supports, that the pickers may reach the hops easily.

4393. The picking should commence where the crop is ripest, which is always round where the male plants grow. It is conducted by whole families, it being the interest of the hop-farmer to gather together as many hands as he can, that the picking season may be as short as possible. One month will suffice, under any circum-

stances, to pick a hop-garden, but the more usual time is three weeks. In picking, every leaf should be taken away, and all the inferior hops separated from the good.

4394. Hops, when picked, are either put in baskets containing 7 or 9 bushels each, or in bins on cloths made on purpose, laid over frames. One man takes charge of the bins, and every particular connected with every set of pickers—consisting of 8 or 10 grown-up persons, or of children capable of performing an equal amount of labour—and the ground is allotted to clear 100 hills by each set of pickers.

4395. Hops are picked by the bushel, and are measured into a basket containing 10 gallons imperial. The price paid varies with the plentifulness or scantiness of the crop, from 3 or 4 to 9 or 10 bushels to the shilling. About three-halfpence a bushel is the usual price paid for picking, and in fine weather, and with a good crop, a family of five will earn from 7s. to 10s. a-day at that rate.

4396. There being 1194 hills in the quincunx, and 1031 in the square mode of cultivation in the acre, (3160,) and allowing one peck of hops to every hill, and 2 lb. to the bushel, the crop will not exceed 5½ cwt. to the acre, which was the ascertained average of the prepared crops for 28 years, from 1807 to 1835; though the crop while green will weigh four times that weight. But the crop of hops is so precarious that, at Binstead in Hampshire, a farmer grew 4½ cwt. on 10 acres in 1825, and 9 tons from the same land in 1826. The general average in 1825 was 108½ lb. the acre, and in 1826 it was 9 cwt. 10½ lb. The attack of insects and of mould, (3184) to (3192,) will make that difference in two consecutive years. The year 1848 proved a good year for the hop, while in 1849 the crop nearly failed.

4397. Immediately on being picked, hops are artificially dried, because they feel damp and clammy, in which state they would not keep, and would mould. They are dried in circular kilns, 16 or 18 feet in diameter, on haircloth, and heated by coal, coke, or charcoal. The kiln-floor

* *Journal of the Agricultural Society of England*, vol. ix. p. 144.

is situate at 10 or 11 feet above the fire, and the height of the kiln is 18 or 20 feet above the kiln-floor, surmounted with a cap-cowl 7 or 8 feet in height, and 3 or 4 feet diameter at bottom, a free circulation of air being kept up through the fire and hops to the top of the kiln. The hops require to be rapidly dried to keep the pickers in operation, and on that account the kilns ought to take on a bushel of green hops on every square foot of flooring, and to be filled twice a-day, giving 5 or 6 hours to each kilnful, so that from 200 to 250 bushels of hops may be drying on each kiln at a time. For two kilns of these dimensions, a cooling room of 20 feet in width, and 40 feet long, is required on a level with the kiln-floor; and another room of similar dimensions, under the cooling room, for stowing and weighing the hops in the bags.

4398. Great caution is required to regulate the fires of the kilns; for if too strong at first, when the hops are naturally moist, they will partake of the smell of fire, and be much deteriorated in quality. The fire may be increased as the drying proceeds, and be pretty brisk near the last; but the heat should not much exceed that of boiling water, 212° Fahrenheit. The hops shrink in bulk as they are drying. About 13 cwt. of coal, with a little charcoal, will dry a ton of hops at a cost of about 25s. the ton, or 1s. 3d. the cwt.

4399. Sulphur is also used in the drying of hops, from the weight of a quarter to one cwt. to the ton of hops. It should be cautiously employed at first, otherwise a fierce heat will be excited. The object of using sulphur seems to be to improve the colour of the hop, for it is of importance to the seller to present his hops in the market with a light-coloured delicately greenish hue. The hops from Farnham have long been esteemed the best for their delicate colour, chiefly derived from great care in subdividing the pickings, and partly, no doubt, from the use of sulphur in the drying process. It is surprising that purchasers who are judges of hops submit to sulphur being used to affect the colour, unless they are glad to employ it as a means of deceiving customers who never saw hops growing, and know not how they are treated. What would be

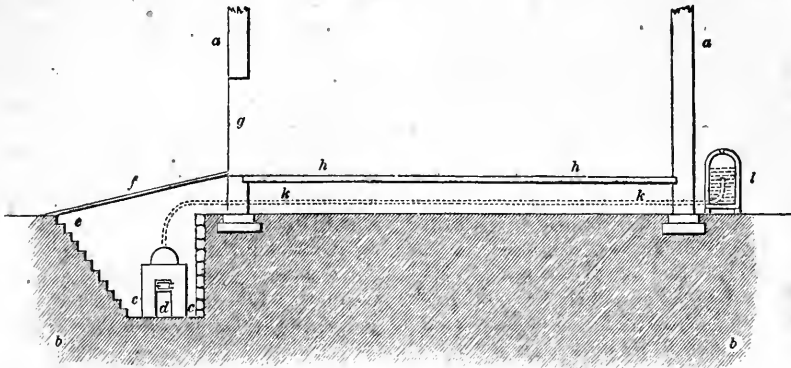
thought of a corn-farmer, were he to fumigate the barley he had to dispose of with sulphur, in order to make the bright-coloured, over-ripened, and stained samples seem all alike? If light-coloured hops are indispensable to the brewer, let him fumigate it, when he gets it, with as much sulphur as he pleases; but let the farmer deal only in the genuine article, the production of the soil—let him always support a character for downright honesty. If he must have fair-coloured hops, to please one class of his customers, let him pick them in the proper season, and exercise his skill in preserving them in the best way, but let him eschew every species of deception. And what avails him the use of sulphur, after all, when the ale brewers alone like the light-coloured, and the porter brewers alone desire the brown-coloured hops? In producing both varieties, he will have customers for both, although he did not use a particle of sulphur.

4400. The hops, when taken from the kiln, are laid in heaps on the cooling-floor, not only to cool, but to acquire a state of adhesiveness, which, though dry, causes it to lump together when squeezed in the hand, and yet not so much as to lose its elasticity. This is an important point in the process of preparing hops for packing, for if they are not sufficiently dry, they will not keep, and if too much dried they will become brittle, break into pieces, and be unsaleable. It is, therefore, better that there be a few tough parcels, to put back again upon the kiln, than that the whole be too dry to injure its quality materially. The drying will cause a loss of weight of 4 lb. at least in the green state for every pound of prepared hops.

4401. Since the heat for driving off the moisture from hops is not great, it might perhaps be as efficaciously done, and certainly more safely, by means of hot water, instead of open or furnace fires. It might, perhaps, be effected by such an arrangement of a hot water apparatus as is shown in fig. 388, which gives a vertical section of a drying-house and apparatus, where *aa* are the walls; *bb* the ground on which the house is built; *cc* a place excavated in the ground in front of the house, in which the boiler *d* for heating the apparatus is

situate; *f* the gangway up to the door *g*, adapted for the drying of hops, perhaps stretching across the excavation; *h h* the perforated cast-iron plates, like the flooring of grain kilns in Scotland, through

Fig. 388.



LONGITUDINAL SECTION OF THE HOP DRYING-HOUSE.

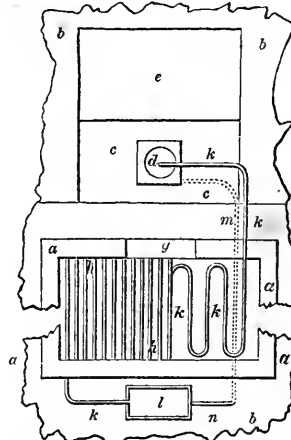
which the heat would ascend from the system of pipes *k k*, traversing the space between the drying floor *h h* and the ground *b*; *l* is the cistern for feeding the boiler and pipes with water. This cistern is supplied with cold water from a pipe, and it is also provided with a waste pipe, to allow any water of expansion to escape.

4402. As the pipes in this apparatus are always open to the atmosphere, any steam or vapour generated can easily escape; and it is evident that, in an apparatus constructed in all its parts on the same level, the heat can never exceed the point of boiling water, 212°. If the feed cistern, however, be elevated at a considerable height above the boiler, the pressure on the water in the latter will be greater than usual, and the boiling point will be raised in proportion to the height of the supply cistern. Thus, in an apparatus in which the boiler is 60 feet below the cistern and highest parts of the pipes, the boiling point is 270° instead of 212°, and the mean temperature of the circulating pipes, in such a case, will be 185°. By raising the site of the cistern to the required height, a proportionate degree of heat may be obtained from the pipes.

4403. To explain the circulation which the hot water takes in such pipes, we have only to examine fig. 389, where *kkkk* is the ascending pipe, as in fig. 388, supported and kept clear of the ground by non-con-

ducting supports, such as bricks, and seen twisted here in convolutions under the floor. This pipe should be continued to

Fig. 389.



PLAN OF THE HOT-WATER PIPES.

within 16 or 18 inches of the surface of the water in the cistern *l*; *m n* is the return pipe, which should be covered with the non-conducting felt used for covering boilers, and which, of an inch in thickness, costs 2s. the square yard; *a a* are the walls; *b b* the ground; *c c* the excavation; *d* the boiler; *e* the gangway; *g* the door of the drying-room; *h h* the drying-floor above the pipes.

4404. The hops are put into the bags in

the stowing-room by means of an opening in the floor of the drying-room into bags suspended for the purpose, and the bags are named *bags* and *pockets*. A bag is fixed by statute to be 4 feet wide and $7\frac{1}{2}$ feet long, to consist of $5\frac{1}{2}$ yards of cloth, weighing $5\frac{1}{2}$ lb., and costing 6d. the yard; and it holds 2 cwt. 2 qr., or 280 lb. gross, and 252 lb. nett, the law allowing a deduction in the weight of hops weighed up, one pound for every 10 lb. gross weight. A Kent pocket is 3 feet wide, and $7\frac{1}{2}$ feet long, to consist of 5 yards of cloth at 7d. the yard, to weigh 5 lb., and to contain 1 cwt. 2 qr. 5 lb. gross weight of hops. The hops are tramped into these bags by a man, while a boy supplies him from a basket, and it will take him 3 or 4 hours to tramp each bag, and to tramp 4 bags at 9d. each is a very good day's work for a man. In treading, the man becomes covered with yellow dust, to which powder Dr Ives ascribes the whole virtue of the plant. It nearly chokes the man, and he must be supplied with beer to keep his throat clear. Hops cannot be too firmly trod in, for the better to exclude the air, for which end the Bramah hydraulic press has been recommended for pressure, and also painting the outside of the bags. It is difficult, however, to exclude the air from hops, which makes them shrink in, and lose from 5 lb. to 10 lb. the cwt., on which account old hops are not worth half the price of new. Those containing the most seed will retain their weight the longest, and therefore the plants which grow nearest the male produce the best hops for keeping. Damp ruins hops, and those which absorbed most sulphur and saltpetre in the drying keep the worst.*

4405. After being packed, and weighed by the excise, hops, after remaining 12 hours, may be removed anywhere for sale. The nominal duty on hops is 2d. per lb., but with the drawback on the weight of one pound in every 10 lb., the duty is 16s. 9½d. $\frac{1}{5}$ the cwt. instead of 18s. 8d., at 2d. per lb.: this, with the additional 5 per cent duty, makes the entire duty payable £17, 12s. 9½d. the ton, or 17s. 8d. the cwt. Taking the crop of hops at the general average for a number of years at $5\frac{1}{2}$ cwt. the acre, and the duty with the

deduction of the drawback of one pound in every 10 lb., the impost still amounts to the considerable sum of £4, 12s. 3d. the acre; and on the supposition that 53,816 acres are under the cultivation of hops, the average annual duty payable on them must amount to £248,226, 6s. Why such a direct impost on the produce of the soil, as the duty on hops is, should be continued to be levied at a period of the history of the country when reductions on the importation of foreign products of the soil seem the determined policy of government, requires a definite answer. It seems to me a misnomer to call that free-trade which relieves the foreigner from the interference of the customs, while our own people are subjected to the trammels of the excise.

4406. Whenever the bines are cleared of the hops, they ought to be taken off the poles, and the poles piled in a place of safety from wet. After the picking is all concluded, the poles are stacked up in the ground, to be near at hand when wanted. When the culture is followed in the square form, as in fig. 250, they are put up in conical stacks, with the sharpened ends on the ground, having four legs striding over a hill which should be right under the centre of the stack. The triangular form of culture, fig. 251, admits of the stack being supported with six legs, each leg in one of the six spaces around the centre of the hill, the apex of the stack being also right above that point. The stacks stand firmer on six than on four legs, and they also stand clearer of the hills, which is necessary, that every hill may be dug around. Each leg of the stack should be bound round with three bines, deprived of their leaves and twisted into a rope, which binds the stack close and compact, and prevents the poles being stolen, or a theft more easily discovered. The small refuse poles are bound together, separating those which may be used for the young bines of the first year, from those which may be burned into charcoal.

4407. The following is the cost of picking, and the subsequent expense on a ton of hops per acre, averaging 1300 bushels of green hops to the ton, as calculated by Mr Rutley:—

* *Lance's Hop-Farmer*, p. 111-26.

Picking 1300 bushels, at 8 bushels for 1s.,	£8 2 6
10 binnets at 2s. 3d. each, over 10 bins companies, of 8 pickers each,	1 2 6
1 man to measure hops,	0 3 0
1 lad to tally and keep accounts,	0 3 0
Boy, van, and 1 horse to carry hops and baskets,	0 6 0
Fuel for drying hops,	1 5 0
Carriage of fuel,	0 5 0
Sulphur, $\frac{1}{2}$ cwt. to a ton of hops at 12s. per cwt.,	0 9 0
65 yards of cloth for 13 pockets, at 7d. per yard,	1 17 11
Making and marking 13 pockets, and ink, at 2d. each,	0 2 2
Treading and putting in 13 pockets, at 10d. each,	0 10 10
Driers, one at 6s., and an under one at 5s. a-day,	0 11 0
5 gallons of beer for driers, treaders, &c., at 1s. per gallon,	0 5 0
Annual supply of new pokes, and tear and wear of old,	0 6 0
Wear and tear of oast hairs, and hop bins, &c.	0 5 0
Men to weigh hops, move loads, &c.,	0 6 0
Loss of time by weather, 3 days' work, £7, 11s. 6d., say,	0 10 0
Wood for fuel, and straw for stranger pickers,	0 10 0
Gift to each picker and binman, at 1s. each, with beer,	0 8 0
Carriage of 13 pockets to London, at 2s. each,	1 6 0
Factor's commission on 13 pockets, at 4s. each,	2 12 0
	£21 5 11
Duty,	17 12 9 $\frac{1}{2}$
	£38 18 8 $\frac{1}{2}$

“In blight years,” concludes Mr Rutley, “as much more per bushel is given for picking, and as there will not be so many hops, it will cost more per ton to pull the poles; and taking it in round numbers, if we were to average the cost of picking, and subsequent expenses, one year with another, at £40 the ton, 40s. the cwt., we should not be very wide of the mark.”*

4408. The hop is not a native of Britain, nor was it known in this country till the reign of Henry VIII., in 1524,† after the return of his expedition to the Netherlands against Tournay in that year. We therefore conclude that the art of using hops was learned during that enterprise. It is probable that the Dutch gardeners, who came to England during Henry's reign, might have brought over some hop plants with other roots and seeds, and that we then availed ourselves of the manner of cultivating this bitter herb. From them we probably derived the name, which, in German, is *hopfen*; and *hoppe*, hop, and *hoperuyt*, in Dutch. It had not become a favourite with the people for many years after that period; for Walter Blith records, in 1653, this remarkable popular error, that “It is not many years since the famous city of London petitioned the parliament of England against two nuisances, and these were Newcastle coals in regard to their stench, &c., and hops, in regard they would spoil the taste of drink, and endanger the people.”‡ The use of hops was therefore forbidden by an act of parliament in the reign of

James I. This act was little attended to, and never having been repealed, is strongly contrasted by the act of Anne, which inflicts a penalty of £20 on all brewers who shall use any other bitter than that of hops in their malt liquors.§

4409. Such has been the increase of the culture of the hop since that period, that in 1835 the exportation to foreign countries amounted to 1,091,659 lb. or 487 tons 6 cwt., of which only 29 $\frac{1}{2}$ tons were of the growth of 1835, and 74 $\frac{1}{2}$ tons of the year 1834—the remaining quantity being made up of old ones, together with 2 tons of foreign. The returns of 1848 do not mention hops.||

4410. Hops may be used medicinally: a pillow of hops will insure sleep to a patient in delirious fever when every other expedient will prove ineffectual. The imbricated scales of the hop are scattered over with resinous spherical glands, which are easily rubbed off, and have a powerful agreeable odour and bitter taste, and their bitter principle has been named *lupuline*. By pressure hop-heads yield a green, light, acid oil, called *oil of hops*, to which the plant owes its peculiar aroma. The best hops are grown in England, and those of Kent afford the largest cones, and are most productive in useful secreted and soluble matters; and those of Worcester have an agreeable mildness of flavour, greatly admired by many ale drinkers. Next to the English are the hops of Alost in Belgium.

4411. “The best hops,” says Dr Ure, “have a golden yellow colour, large cones, an agreeable aroma; when rubbed between the hands, they leave yellow traces, powerfully odoriferous, without any broken portions of the plant, such as leaves, stems, and scaly fragments. When alcohol is digested in good hops, from 9 to 12 per cent of soluble yellow matter may be obtained by evaporating it to dryness. This is a good test of their quality.”¶

4412. The composition of the ash of the hop is as follows, according to Mr Nesbit:—

	Golding Hop.	Yellow Grape Hop.
Potash,	24.50	18.61
Lime,	15.56	23.75
Magnesa,	5.63	6.13
Phosphate of iron,	7.26	6.79
Sulphuric acid,	5.27	4.16
Phosphoric acid,	9.54	5.26
Carbonic acid,	2.61	3.36
Chloride of sodium,	7.05	3.18
Chloride of potassium,	1.63	2.21
Manganese,	...	1.59
Silica,	20.95	24.96
	100.00	100.00
Percentage of ash,	9.90	15.80

* *Journal of the Agricultural Society of England*, vol. ix. p. 566-82.

† Beckman's *History of Inventions*, vol. iv. p. 339.

‡ Blith's *Improveur Improved*, p. 240.

§ Philips' *History of Cultivated Vegetables*, vol. i. p. 240. || Lance's *Hop-Farmer*, p. 200.

¶ Ure's *Dictionary of the Arts—art. Beer*.

4413. Weight of the various mineral ingredients, removed from an acre of land by the Golding hop, is as follows:—

MINERAL INGREDIENTS.	500 lb. of hops.		1461 lb. of leaves.		890 lb. of bines.		Total of hops, leaves, and bines.	
	lb.	oz.	lb.	oz.	lb.	oz.		
Potash,	11	3½	2	10	2	6	16	3½
Soda,	7	14	0	1	0	0	0	1
Lime,	2	9	0	6	0	6½	2	15½
Magnesia,	3	5	0	10	0	0½	3	15½
Phosphate of iron,	2	6½	0	14	0	5½	3	10
Sulphuric acid,	4	6	0	7	0	9½	5	6½
Phosphoric acid,	3	3½	1	10	0	10	5	7½
Chloride of sodium,	0	12	2	2	0	15	1	11
Do. of potassium,	9	9	2	2	0	9½	12	4½
Silica,	44	8	17	6	9	11	71	9½

4414. Weight of the various mineral ingredients removed from an acre of land by the Yellow Grape-hop, is as follows:—

MINERAL INGREDIENTS.	1733 lb. of hops.		380 lb. of leaves.		1153 lb. of bines.		Total of hops, leaves, and bines.	
	lb.	oz.	lb.	oz.	lb.	oz.		
Potash,	42	6½	4	4	6	15	53	9½
Soda,	54	14	1	14	1	4	3	2
Lime,	13	15	5	2	6	12	25	13
Magnesia,	15	7½	0	7	1	1½	17	0
Phosphate of iron	9	7½	3	0	1	11	14	2½
Do. alumina,	11	15½	3	0	4	5½	19	5
Sulphuric acid,	7	0	3	14	5	5	16	3
Phosphoric acid,	4	15	..	..	..	..	4	15
Chloride of sodium,	3	10	..	..	..	..	3	10
Do. potassium,	56	14½	16	14	3	0	76	12½
Manganese,	219	13	65	2	40	8	325	7*
Silica,								

4415. The composition of the ash of the flower of the hop, according to the analysis of Mr Frederick Eggar, are as follows:—

	Golding Hop.	Yellow Grape Hop.	Mean of analysis
			in a ton of hops.
Potash,	24.88	25.56	29 5
Lime,	21.59	18.47	27 5
Magnesia,	4.69	5.27	7 5
Peroxide of iron,	1.75	1.41	2 4
Sulphuric acid,	7.27	11.63	12 3
Phosphoric acid,	14.47	17.58	25 2
Carbonic acid,	2.17	4.54	...
Chloride of sodium,	3.42	1.12	2 1
Chloride of potassium, . . . . .	...	4.34	4 6
Silica,	19.71	9.99	25 0
	99.95	99.96	136 1
Percentage of ash, } calculated dry, }	5.95	7.21†	

4416. As spent hops are used for manure, the analysis of their ash, by Mr Nesbit, may prove instructive:—

* *Journal of the Agricultural Society of England*, vol. vii. p. 212-18.

† *Ibid.* vol. ix. p. 145.

‡ *Ibid.* vol. vii. p. 220.

§ *Lawson's Agriculturist's Manual*, p. 63.

Potash,	1.45
Lime,	23.70
Magnesia,	2.75
Phosphate of iron,	2.50
Sulphuric acid,	3.05
Phosphoric acid,	4.10
Carbonic acid,	9.00
Chloride of sodium	2.95
Chloride of potassium,	0.70
Silica (soluble)	27.10
Sand and charcoal,	21.80
	99.10
Percentage of ash,	10.40‡

4417. The import duty on hops is £2,5s. the cwt.

ON THE SOWING OF WINTER BEANS.

4418. The common field horse-bean, fig. 189, it is well known, is unable to withstand the weather in winter. A new bean to the agriculture of this country was introduced into England in 1825, and is found to stand the winter in the south of England with considerable certainty. It is doubtful whether it will bear a Scottish winter, as the few attempts which have been made to grow it have been rather unsuccessful; and unless the autumn is very favourable to vegetation, it is believed that it will not prove profitable.

4419. This bean is called the winter, and sometimes the Russian, bean. It grows to the height of 3 or 4 feet; is remarkably hardy and prolific; the seed being small, heavy, and very plump, seldom having any depression in its sides. It is of the same colour of the common bean, with a dark-greenish spot on the short side, a little below the termination of the small black eye. It was at first confounded, but is now proved to be a distinct variety from the Heligoland bean. §

4420. The only one I have heard who cultivates the winter bean is Mr Hewitt Davis, Spring Park, near Croydon, in Surrey, who thinks it a valuable crop in soils unsuited to the common bean. If taken after potatoes, the land should be drilled in the double form (2397) in September, and the seed, from six to eight pecks to the acre, then sown upon the drills by the bean barrow, fig. 219. The

land is cleaned with the scuffer, fig. 262, drill-grubber, fig. 264, and hand-hoe, fig. 266, in spring. It comes early in spring into blossom, may be harvested in some years as early as July, and yields from 4 to 5 quarters an acre. It possesses the advantage over the common bean of never being attacked by the black dolphin or collier, fig. 335, probably on account of its rapid growth anticipating the period of the existence of that pest; and this discrimination was strikingly exemplified by comparison in 1847, a year in which a large proportion of the common bean was destroyed in England by this aphid.*

4421. If the winter bean is taken after stubble, the land should be drilled in the double manner (2397,) dunged in the drill, as in (2433,) the seed sown on the top of the dung by the drill-barrow, fig. 219, in the same quantity as specified for beans in spring (2442,) and the dung and seed covered over with the double mode of drilling. Other modes of sowing beans with and without manure are described from (2427) to (2432.)

4422. After the autumnal dunging, the land should be top-dressed in spring with some alkaline manure, as nitrate of potash, wood ashes, or common salt, 2 or 3 cwt. to the acre.

4423. Mr Davis grows turnips between the rows of winter beans, and carrots may be grown in the same manner; but although Mr Davis regards the turnips as valuable for folding sheep upon them after the removal of the beans, it is questionable farming to make the land produce two crops at the same time. Such a style of farming is common in Flanders, and it is carried there to the extreme length of growing a green crop amongst grain, such as carrots amongst barley, but the green crop is unworthy of the name. Should the stone turnip (4358) amongst winter beans be desired, the beans may be sown in double rows at fifteen inches apart, and nine feet between the double rows, which would afford the ordinary room of twenty-seven inches between the two drills of turnips. For two rows of carrots seven feet between the double rows will suffice.

ON THE PULLING, STEEPING, AND DRYING OF FLAX.

4424. We left the flax crop after it was weeded, in (3115,) and shall now describe the mode of removing it from the ground.

4425. The flax plant is removed from the ground by being pulled up by the roots, and not by being cut over with any sharp instrument. The pulling is not attempted until the plant has done flowering, and the seed has attained a certain degree of maturity in the capsule or boll which contains it. The test of *ripeness*, according to Mr Henderson, is this:—"I have found the test recommended by Mr Boss, to ascertain the degree of ripeness that gives the best produce, with the finest fibre, perfect. It is this: Try the flax every day when approaching ripeness, by cutting the ripest capsule on an average stalk across, horizontally, and when the seeds have changed from the white, milky substance which they first show, to a greenish colour, pretty firm, then is the time to pull. The old prejudice in favour of *much ripening is most injurious*, even as regards quantity; and the usual test of the stalk stripping at the root and turning yellow, and the leaves falling off, should not be depended on. Where there is one man that pulls too green, five hundred over-ripen."

4426. When thus properly ripened, the flax should be *pulled* in this way:—"I use the Dutch method, by catching a few stems of the flax at a time close below the bolls, which allows the shortest of the flax to escape. With the next handful the puller draws the short flax, and keeps the short and the long each by itself, to be steeped in separate ponds. It is most essential to keep the flax even at the root end, and this cannot be done without time and care; but it can be done, and *should always be done*. The *beets* or sheaves should always be small, equal sized, straight and even, and should never be put up in stooks or winrows, but taken to the pond the day they are pulled, or the day after at longest, especially in bright weather—for the *discoloration produced by the sun on green flax will never be removed till it goes to*

* Davis's *Farming Essays*, p. 64.

the bleacher, and will give him some trouble also."

4427. On being pulled the plant is deprived of its bolls or seed-capsules by *rippling*, which consists of drawing the stems of the plant through the teeth of an iron comb 8 inches in length, set upright upon a form, across which two men sit opposite each other, and ripple their hands alternately. The ripple is placed on a barn sheet, (1740.) The arrangement of labour should be such that the rippling should go on simultaneously with the pulling, and with as little loss of time as possible. The rippled plants should be tied in sheaves to be taken to the watering-pool to be steeped. Some steep the bolls on the plants, but no good is attained thereby.

4428. Next comes the *steeping*, which is a most important process, and is the one least understood by the growers of flax in this country. The object of steeping the flax-plant is, that as the stem of flax consists of two parts, possessing very different properties—one, the outer, fibrous, affording the flax which is kept—the other, the interior, pithy, to be got rid of by fermentation in steeping and loosening its hold of the fibre. The adhesive substance betwixt the two is mucilage, and the sooner the flax is put into steep after being pulled, the more mucilage will be dissolved from it. If the steeping is as long continued as to affect the texture of the fibrous coating, the flax will be injured: and should it not be continued until the pithy matter may be easily loosened, much labour will afterwards be required to get rid of it. Proper steeping, then, is not only an essential, but a nice process, and clear instructions regarding it are valuable:—"Flax is subject to injury from neglect in every process, but in steeping especially. The water brought to the pond should be pure from all mineral substances, clean and clear. The water from large rivers is generally to be preferred; but spring-water which has run some hundred yards becomes soft, and will have deposited any mineral impurities it may have contained; but that immediately from the spring seldom does well. If the water be good and soft, it is injurious to allow it to stagnate in the pond before being used for steeping. I put in two layers, each somewhat exposed, with the root-end

of each downwards: one layer at a time is said to be safer, and perhaps is so, although I have tried both ways and have observed no difference. The flax should be placed rather loose than crowded in the pond, and laid carefully straight and regular. Having an abundant supply of water, I do not let any into the pond till the first layer is first placed in it. I cover the flax with sods laid perfectly close, the shear of each fitting to the other. Thus covered, it never sinks to the bottom, nor floats above the water, nor is affected by air or light. It is generally watered in 11 or 13 days. A gentle stream should, if possible, always pass slowly over the pond; it carries off impurities, and does not at all impede due fermentation. Flood and impure water should be carefully kept off; and perhaps the best way to do this is to make a drain or ditch around the pond. The greatest cause of injury in steeping is exudation of water from the sides or bottom of the pond. Stripe and discoloration are mostly imputed to the quality of the water brought to the pond; whilst in most cases the water oozing from the sides and bottom of the pond itself is the cause. Even if such water were pure, which it seldom is, it is injurious; but when impregnated with iron or other materials, it does immense harm. If such ponds must continue to be used, the injury may be partially amended by draining around the sides and ends, at 6 or 8 feet distance, and 18 inches deeper than their bottom, and filling the drains with tiles or stones. No other thing I know of does so much injury as this springing of water within the pond. The Dutch test of being sufficiently watered is certain and perfect; at least, I never found it otherwise. It is this:—Try some stalks of average fineness by breaking the woody part in two places, about 3 inches apart, at the middle of the length; catch the wood at the lower end, and if it will pull downward freely for those three inches, without breaking or tearing the fibre, it is ready to be taken out. This trial should be made every day after fermentation subsides, for sometimes the change desired is rapid. Flax is more frequently injured by too little than too much of the water. Great care and neatness are necessary in taking the flax out, as broken or crumpled flax will never reach the market. Set the sheaves on end

against one another as taken out of the pond, to drain the water off them the more quickly. Spread the flax on the same day it is taken out, unless it is happens to be heavy rain. Light rain does little harm; but, in any case, spread the next day, for it will heat in the pile, and that heating will be destructive."

4429. Flax "should be *spread* even, straight at its length, not too thick, and well shaken, so that there shall be no clots; indeed, if possible, no two stalks should adhere. I have ever found it injurious to keep it long on the grass: it is in the steep the wood is decomposed; on the grass the fibre is softened and the wood little if at all affected. I rarely let it lie more than 5 days, sometimes only 3: one year it had only 3 days, and I never had better flax. It should never, if possible, be spread upon the ground where it has grown—it claps down, and the clay and weeds discolour it: clean lea, or lately cut meadow, is the best ground."

4430. "*Lifting*, like all other operations, requires care and neatness to keep the flax straight in its length, and even at the roots. This operation is too frequently hurried and coarsely done."

4431. "If the steeping and grassing have been perfect, flax should require no fire; and to make it ready for breaking and scutching, exposure to the sun should be sufficient; but if the weather be damp, the flax tough, and must be wrought off, then it must be fire-dried. Such drying is always more or less injurious; and if it be put on the kiln in a damp state, it is ruinous; it is absolutely burnt before it is dry. All who can afford it should keep such flax over to the ensuing spring or summer, putting it dry into stacks, when it will work freely without fire-heat."

4432. In his concluding remarks, Mr Henderson shows that he is well acquainted with the nature and effects of flax culture:—"The proper culture and preparation of flax require more care, exertion, and expense than the old slovenly method; and those who will not give those requisites, would do wisely to abstain from growing

flax altogether. Any other crop will abide more negligence. So much has been said and written of late of the advantage of flax-culture, that it is to be feared some may be led to carry it to an undue extent, and sow it on land not fitted for it; indeed, this has already been often done, and I know of nothing more injurious to the farmer. Flax is proverbially either the very best or the very worst crop a farmer can grow."*

4433. I think that, as far as the farmer is concerned, he should have nothing to do with the steeping of flax, nothing to do with its manufacture at all, which should be left entirely to the skill and practical management of the manufacturer, who must know, much better than the farmer, the processes best suited to preserve and render the fibre most fitted for his own purposes. And by following what is termed the Courtrai system of management, it is in his power to avoid all trouble and risk incidental to the steeping and dew-retting of the crop. This system is simply to set up the sheaves, on being pulled and rippled, into stooks to be dried, and, after it is so, to stack it, ready for sale to any purchaser, or to dispose of it in the stook. The steeping can be done after the plant has been dried, although it takes a longer time to take effect; and the steeping may be superseded altogether, now that the mucilage and pith may be dissolved and removed by a process of heating in steam, which has been invented by an American gentleman, Mr R. B. Schenck. His apparatus consists of a steam-boiler and vat, in which is maintained the flax and water at a temperature of 90° Fahrenheit, for 60 or 80 hours, at the end of which time the flax is as completely fitted for drying and breaking as when steeped for 14 days. The water is heated by the steam passing through a coil of pipes lying in the bottom of the vat, which has a false perforated bottom, upon which the flax is laid.

4434. The crop of flax, after it is dried, is bulky for its weight, and yields from 3 to 10 cwt. per acre of dried plants. From 30 to 40 stones, of 14 lb. each, an acre of *dressed* flax, is considered a fair crop, and, if of *fine* quality, will fetch perhaps £90

* Henderson *On the Cultivation of Flax*, p. 1.

a ton—that is, from 4 to 5 acres are required to furnish 1 ton of flax. The return obtained is from £18 to £22 per acre, exclusive of the expense of preparing it by beetling, scutching, and heckling, which will still leave from £10 to £15 an acre of profit. But should the flax prove coarse by improper management, or be injured in drying, much waste will be occasioned in dressing it, and the profit reduced to perhaps one-third of those amounts. So that the safest plan for the farmer to pursue, in regard to his flax crop, is to dry it for sale, after the pulling and rippling. The observation of Mr Henderson, of flax being either the best or worst crop for the farmer, receives corroboration according to the manner in which it was treated.

4435. When the flax is raised of fine quality, the seed is not of much value as a marketable commodity; but the bolls with the seed in it, such as it is, make good food for cattle, and have been successfully used as such by that eminent breeder, Mr Hugh Watson, Keillor Farm, near Coupar-Angus. When the flax is allowed to stand, more for the sake of obtaining seed than fibre, every 8 bushels of bolls may be expected to produce one bushel of clean seed; and the price of the bolls, after being dried in the sun, is 6d. the bushel; at which price the farmers of Ireland express themselves satisfied at the profit derived from this part of the flax crop.*

4436. The structure of the flax plant, and the proportions which the parts bear to one another, is thus described by Dr Ure:—"In it two principal parts are to be distinguished—the woody heart or boon, and the *harl*, (covered outwardly with a fine cuticle,) which encloses the former like a tube, consisting of parallel lines. In the natural state the fibres of the harl are attached firmly not only to the boon, but to each other, by means of a green or yellow substance. The rough stems of the flax, after being stripped of their seeds, lose in moisture, by drying in warm air, from 55 to 65 per cent of their weight, but somewhat less when they are quite ripe and woody. In this dry state they consist, in 100 parts, from 20 to 23 per cent of harl, and from 80 to 77 per cent of boon. The latter is composed, upon the average, of 69 per cent of a peculiar woody substance; 12 per cent of a matter soluble in water; and 19 per cent of a body not soluble in water, but in alkaline lyes. The harl contains, at a mean, 58 per cent of pure

flaxen fibre, 25 parts soluble in water, (apparently extractive and albumen,) and 17 parts insoluble in water, being chiefly gluten. By breaking the harl, with either hot or cold water, the latter substance is dyed brown by the soluble matter, while the fibres retain their coherence to one another. Alkaline lyes, and also, though less readily, soap water dissolves the gluten, which seems to be the cement of the textile fibres, and thus set them free. The cohesion of the fibres in the rough harl is so considerable, that by mechanical means, as by breaking, rubbing, &c., a complete separation of them cannot be effected, unless with great loss of time and rupture of the filaments. This circumstance shows the necessity of having recourse to some chemical method of decomposing the gluten. The process employed with this view is a species of fermentation, to which the flax stalks are exposed. It is called *retting*, a corruption of *rotting*, since a certain degree of putrefaction takes place."†

4437. "Mr James Thomson and Mr Bauer," relates Dr Thomson, "have shown, that the fibres of flax are transparent cylindrical tubes, articulated, and pointed like a cane; while the filaments of cotton are transparent glassy tubes, flattened, and twisted round their own axis. A section of a filament resembles, in some degree, the figure 8, the tube originally cylindrical, having collapsed most in the middle, forming semitubes on each side, which give to the fibre, when viewed in a certain light, the appearance of a flat ribbon, with a hem or border on each edge. The uniform transparency of the filament is impaired by small irregular fissures, probably wrinkles arising from the desiccation of the tube. In consequence of this difference between the structure of linen and cotton fibres, Mr Thomson and Mr Bauer were enabled to ascertain, that the cloth in which the Egyptian mummies are wrapt is always linen, and never cotton. It is clear from this, that the opinion entertained by some, that what is called in our translation of the Old Testament *fine linen* of Egypt, ought to be the *cotton cloth* of Egypt, is erroneous. We have no evidence from the cloth wrapt about ancient mummies, that the Egyptians in those early times were acquainted with cotton."‡

4438. The desire to grow flax has been strongly expressed, in Ireland, for a few years past; and, on the stimulus given to the subject, by the society instituted for the purpose of promoting its culture, little doubt exists that more flax is grown at present, in Ireland, than has been for many years bypast, and as so large an importation took place so lately as 1,052,089 cwt. in 1847, and 1,462,097 in 1848, the probability is, that the demand for it will be of so permanent a character as to encourage its growth for many years to come. But while the Irish farmers have been supplied with wholesome advice by the kind offices of the society referred to, there have not been wanting

* Sproule *On the Growth and Management of Flax in Ireland*, p. 19, note.

† Ure's *Dictionary of the Arts*,—art. *Flax*.

‡ Thomson's *Organic Chemistry—Vegetables*, p. 849.

injudicious friends to mislead them into a belief that flax and flax seed may be grown together, both equally good, and that the flax plant is not an exhauster of the soil. Such fallacies have doubtless been propagated by persons unacquainted with agriculture,—for every farmer in Scotland who has raised flax knows, that if it is allowed to stand until the seeds are nearly ripe, the fibre becomes coarse. The finest flax seed comes to this country from Russia, and from thence also is imported the coarsest flax. I have been informed, by an extensive grower of flax in Lithuania, that, to raise the best quality of seed, the seed is sown thin, that the plants may find room to throw out branches, and the fibres then become short and coarse. There is, therefore, this dilemma in the matter, the quality of the flax or of the seed must be sacrificed, for both of the best quality cannot be simultaneously raised. The seed alone will not pay the expense of culture. Seed is produced from 6 to 12 bushels an acre: taking the largest, 12 bushels, 1¼ quarter; and supposing it all fit for sowing, and worth, at the highest current price of 1850, 5s. the quarter, the gross return would only be £4, 2s. 6d. the acre.

4439. Every farmer also knows that if flax is cultivated as a green crop, having the manure applied directly to it, its fibre becomes coarse; and if cultivated as a white crop, it must either occupy the place of another white crop, and compete with it in profit, or be taken after another white crop, when it must exhaust the land. It was this last position which flax occupied when cultivated in Scotland; and it left such evident marks of exhaustion upon the soil, that landlords prohibited its culture in express terms in the lease. This result is well known to the agricultural community; and yet the Irish farmer has been informed, on the authority of Sir Robert Kane, that “the igneous or woody fibre, which finally is converted into the linen thread, is composed of the same elements as starch and sugar, and in nearly the same proportions. Hence this fibre, which constitutes the entire money value of the flax crop, is produced during the life of the plant, by the elements of the atmosphere; and the materials taken from the manure and from the soil are, in reality, employed by the plant in organising substances which do not make any return to the farmer, but which are, on the contrary, under certain circumstances, considered to be positively a disadvantage. It is therefore of importance that it should be understood, that, by a proper system, the growth of flax and similar fibre crops should be destitute of all exhausting influence.”* The sentiments just expressed seem to imply that the fibre of the flax plant contains no mineral ingredients whatsoever: an opinion at all times improbable, and now proved to be unfounded, as may be seen in the results of the analyses of the ashes of dressed flax, and of its refuse, the pob, by Professor Johnston:—

	FLAX.	POB.
Alkaline salts, chiefly common salt } and sulphate of soda, }	8-93	9-58
Phosphates of lime and magnesia, } and a little phosphate of lime, }	17-80	14-12
Carbonate of lime,	45-56	51-43
Carbonate of magnesia,	6-38	9-24
Insoluble siliceous matter,	21-24	15-63
	100-00	100-00
Percentage of ash in the dry fibre,	1-29	1-78†

4440. After giving the analysis of flax-steep extract, with and without ashes, Sir Robert Kane observes, that “It is thus seen that the steep-water dissolves out a great quantity of nitrogen, and of the inorganic materials of the stem; in fact, that it removes from the plant almost everything that the plant removes from the soil. This is confirmed by looking at the composition of its ashes, which are shown by the following analytical results. There are found 42 parts of ashes in every 100 parts of flax-steep extract, consisting of—

Chloride of potassium,	3-8
Sulphate of potash,	4-4
Carbonate of potash,	3-8
Carbonate of soda,	13-2
Carbonate of magnesia,	2-0
Carbonate of lime,	4-0
Phosphate of iron and alumina,	3-2
Phosphate of lime,	2-1
Silica,	5-5
	42-0

The steep-water thus dissolves, especially the alkaline ingredients, and the phosphates of the plant, and hence leaves the rotted stems in a condition of almost pure ligneous matter.” The conclusion formed is, “that the materials drawn from the soil by such a crop, (flax,) should be found in the waste products of its manufacture, and should be available by being returned to the soil, to restore it to its original fertility.”‡ “Suppose,” observes Professor Johnston, “the flax-steep water, therefore, to be returned to the land, and even the scutchings also, which is rarely the case, the fibre as it comes from the mill, and even as it goes to market, would still carry off a considerable quantity of valuable matter from the soil.” I will add that, in practice, the land on which flax is sown is never watered afterwards, and the contents of the steeping pool would only put it in a bad state for the succeeding crop; and, besides, the expensive carriage of tons of water would be of no use to such a crop, since the ingredients from flax would only benefit the flax plant. To render the water-carrying therefore profitable, another crop of flax should be taken, which no farmer would do. It has been stated at public meetings in Ireland that I am entirely inimical to the culture of flax in the United Kingdom. Now, the sentiments I have always entertained are, that the flax crop has been found in Scotland to

* Kane's *Industrial Resources of Ireland*, p. 325-6.

† Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 383.

‡ Kane's *Industrial Resources of Ireland*, p. 326-8.

be a very exhausting one to the soil; that it cannot fall to be an exhausting crop if raised after a grain crop; that if raised after a green crop the fibre becomes too coarse to be useful for fine fabrics; that if raised as a substitute for a grain crop, it comes into competition with it on the score of profit; that fine seed and fine fibres cannot be produced by the same plant; that if fine flax is desired to be raised, the seed must be sacrificed, except for the feeding of cattle; and that if fine seed is desired to be raised, the crop must be sown thin, and the flax rendered coarse and short.

4441. Flax is manufactured into fabrics, varying in texture from the coarse bagging employed to pack cotton or hops, to canvass, linen, cambric, and the finest lawn, differing in value between bagging and lawn, from 3½d. to 28s. the square yard. Best Russia flax, in 1850, cost from £34 to £35 the ton; so that a crop of 40 stones should realise for the acre of this coarse quality of flax, from £8, 10s. to £8, 15s. The finest flax realises a price from £90 to £120 the ton.

ON THE PULLING, STEEPING, AND DRYING OF HEMP.

4442. The last notice of the hemp crop, after sowing and weeding, was taken in (3136.) According as it is desired to cultivate the plant for the seed or for the fibre, it should be thinned out in the row after the plants have attained a height of from 4 to 6 inches. If seed be chiefly desired, the plants should stand at 2 feet distance in the row; and if fibre, one foot distance will suffice—the finer the fibre the higher the price will be obtained for it.

4443. The hemp having the sexes on different plants, the entire crop comes to maturity at different times, the male plants becoming mature immediately after they have deposited the pollen on the female flowers, and the female not for three or four weeks thereafter. This difference of time in arriving at maturity causes the inconvenience of reaping the crop at different times, which must be submitted to, although some farmers reap the entire crop at one time, to the injury of the fibre.

4444. When the male plant is ready to be pulled, the leaves hang down and become yellow at the points, and the skin of the stem assumes a white colour. The female plant is not ready for pulling until the earliest seeds begin to assume a brown colour on the apex.

4445. In commencing the harvest the male plants are selected first, and they are easily known by bearing no seed. The crop is reaped by pulling it up by the roots like flax; and care should be exercised in the pulling, not to break the stem when taking a hold of the plant near the root. Before pulling each stem, the leaves should be pinched or cut, and the male tops cut off; and when pulled the stems should be made up in small handfuls, with the roots placed together, and tied in bundles at three places, one near each end and one at the middle, with the small stunted plants found growing between the tall ones.

4446. The bundles should be carried to the watering-pool as soon after being pulled and made up as practicable. It is recommended by some growers to dry the plants for a day before putting them amongst the water; but as the watering only removes the mucilaginous substance by which the fibre is attached to the pith, it is evident that the mucilage will be dissolved more easily, and in shorter time, when the stem is green, than when it has become indurated by drying. The bundles should be put into the pool with the root end downwards, and laid against each other in a sloping direction, and kept under water by the pressure of green turf laid closely above them, to exclude the light. A fermentation ensues in the course of a few days, according to the state of the atmosphere, which has the effect of separating the fibre from the stem. About three weeks will be required to effect this separation entirely; but in case the fermentation should be carried too far, and injury be done to the fibre—and the injurious effect runs its course very rapidly after it has commenced—a bundle should be examined at least every day after a fortnight, and the fact ascertained whether the fibre separates easily from the stem, and whether the stem snaps easily asunder, which when it does, the bundles should be taken immediately out of the water.

4447. As the bundles are taken out of the water, they should be set up against each other, to drip the water from them as much as possible; and when any of them seems dirtied with mud or otherwise, they should be rinsed in the pool before being

taken out. After dripping for a day, the bundles should be taken to an airy place to dry; and the plants may either be spread singly upon a piece of bare grass, or, what is better, spread against a paling or wall having a drying exposure. Hurdles, such as fig. 40, set up with a considerable inclination backwards, form a convenient erection for bearing hemp to be dried.

4448. Three weeks, and even five, according to the state of the weather, will be required to make the hemp completely dry; after which it ought to be again tied into bundles, and built in a stack and thatched, ready to be sold to the best purchaser.

4449. The water in the pool should be soft and clear. Some are of opinion that it should be soft and muddy, the mud promoting the fermentation. Mud may promote putrefaction and heighten the discoloration of the fibre; but clear water is evidently the best means of dissolving the mucilage, and preserving the natural colour of the fibre. A gentle current should also pass over the water of the pool, to carry off the impurities thrown up to its surface by the process of fermentation amongst the bundles, although some growers of hemp maintain that the water should be in a stagnant state; but if a slight current is beneficial to the steeping of flax (4428,) there seems no reason why it should not also confer the same benefit upon hemp, as the object of steeping both plants is identically the same.

4450. By the time the male crop is ready to be taken out of the pool, the female one may be expected to be ready to be pulled. The process of pulling and bundling it is nearly the same as that of the male plant, with the difference, that although the leaves are pinched, the tops are not cut off the female plants, but kept on, and the seed rippled out of them before the stems are ultimately bound up for the watering pool. The rippling of the seed will prevent the watering of the female plants until the day after the pulling. The processes of watering, drying, and stacking are the same in both plants.

4451. I am of the same opinion, in regard to the culture of hemp, as of that of flax, that the farmer should have nothing to do with its manufacture, and that all he should do after the pulling of the crop is to dry it and stack it in the best manner for the manufacturer to purchase. The steam process of Mr Schenck (4433,) or other means, the manufacturer, no doubt, possesses to render the crop available to himself, without the assistance of the farmer; and by such a procedure the farmer will avoid all personal responsibility save in the growing of the crop.

4452. After the seeds have been rippled off, they should be dried and thoroughly won, with as much of the capsules as remain with them, to be given, after preparation, to the cattle in winter as part of their food.

4453. When the crop is raised for seed, the seeds when ripe easily come out of the capsule. When the crop has to be watered, the seed should be rippled off and dried and beaten out afterwards; but when the crop is to be dried without watering, the seed is beaten off the stems after these have been dried for about a week, by being struck against some object, as a stool placed upon a large barn sheet. The seed thus beaten out should be winnowed, and laid in the granary to win. The produce may be expected to be from 2 to 3 quarters an acre, and at 38s. the quarter, the best price in 1850, will yield from £3, 16s. to £5, 14s. an acre.

4454. The produce of hemp is about 40 stones to an acre, the crop varying from 30 to 50 stones an acre, according to the season and the soil. The hemp may be expected to leave a profit of from £5 to £8 an acre, exclusive of the seed obtained in the rippling off the capsules for cattle food.* The best hemp, the Riga Rhine, cost in 1850, from £32 to £35 the ton, so that an acre of 40 stones should realise from £8 to £8, 15s.

4455. The principal use to which hemp is applied is the making of cordage of all kinds, the fibre being both strong and durable. "By this cordage," says Coles quaintly, in his *Paradise of Plants*, "ships are guided, bells are rung, beds are corded, and rogues kept in awe." A first-

* *Wisset's Treatise on Hemp*, p. 93 to 220.

rate man-of-war is said to require 80 tons of rough hemp to supply her with necessary tackle. Taking 40 stoncs the imperial acre as a good crop, 4 acres are required to raise one ton; so that a man-of-war consumes one year's produce of 320 acres of hemp for an outfit of cordage! Old cordage is converted into paper, and therefore should never be destroyed.

4456. I am not aware of any analysis having been made of the ash of the hemp, but the component parts of the ash of American hemp scutchings, by Professor Johnston, are as follows:—

Alkaline salts, chiefly common salt, } and sulphate of soda,	3.32
Phosphates of lime and magnesia, and } a little of phosphate of lime,	19.15
Sulphate of lime (gypsum,)	3.26
Carbonate of lime,	26.45
Carbonate of magnesia,	2.80
Insoluble siliceous matter,	45.02
	<hr/>
	100.00
Percentage of ash in the dry fibre,	<hr/> 14.43* <hr/>

4457. The dried refuse of the stems of hemp, after the fibre has been separated, is used as fuel, and may be converted into charcoal fit for gunpowder.

4458. Dr Taylor says that "the inspissated resinous exudation of the leaves and stems of Indian hemp, known in the East as *churras* and *haschisch*, has been introduced into the country as a substitute for opium. . . . In a large dose Indian hemp produces a pleasant species of intoxication. The nervous system is also most singularly affected, while the intellectual powers remain unaltered. According to Mr Ley, the inebriation is of the most cheerful kind, causing the person to sing and dance; and to eat food with great relish. It also excites aphrodisiac propensities. The intoxication, which lasts about three hours, and is sometimes attended with uncontrollable laughter, is succeeded by sleep. There is no nausea, sickness, or diarrhœa; and the day following there may be slight giddiness, with vascularity of the eyes. If this drug should come into general use, it is not unlikely that it may give rise to serious accidents. It appears to be very uncertain in its effects."†

ON REAPING WHEAT, BARLEY, OATS, AND RYE.

4459. In the case of reaping, I place all the crops, which have occupied our attention hitherto separately, together, as they are all reaped in the same manner, and therefore subject to the same remarks.

4460. As harvest-work requires more

labourers than usually live on the farm, a sufficient number should be engaged beforehand, to assist those on the farm. Farms in the immediate vicinity of large towns may obtain the requisite number of reapers daily, from the nearest town, who will go home to their own lodgings at night; and the convenience of obtaining a day's work at good wages, within a few minutes' walk of their own homes, induces most of the inhabitants of towns, who desire to harvest, to prefer engaging on farms near them; and thus both parties accommodate each other. Such reapers are usually paid their wages in money every evening.

4461. On farms at a distance from towns, no reliance can be placed on their inhabitants as reapers at harvest-work. Labourers must therefore be hired, to remain all the harvest along with the people on the farm. Such reapers receive their food daily as part of their wages, and their money wages are paid them at the termination of their engagement.

4462. To obtain additional hands for a few days, when a large breadth of corn becomes suddenly ripe, in consequence of the state of the weather, and to enable people to obtain harvest-work whose previous engagements are finished, a hiring market is established in every country town early on Monday morning, where reapers and farmers form engagements for the week.

4463. The period for collecting the reapers on the farm is when the grain is just ready to be cut down; for if cut down too soon, or allowed to stand too late, loss will be incurred in both cases. Corn may thus be ascertained when fit to be cut down:—It may be laid down, as a general rule, that corn in a healthy state comes to maturity first in the ear, and then in the straw; and when the straw becomes matured first at the root, the grain suffers premature decay. Whenever the straw is observed to be first ripe at the root, the crop need not be allowed to stand longer on the ground, as it can derive no more benefit from it; and its grain will win as readily in the stook as that unreaped;

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 383. † Taylor *On Poisons*, p. 791.

and whenever the ear is sufficiently ripe, the crop should be cut down, as the straw will win more rapidly in the stook than standing on the ground. The most ready way of judging when the ear is ripe, in wheat and oats, is the state of the chaff in the ear, and of 2 or 3 inches of the top of the straw under the ear. If all these parts are of a uniform straw-yellow colour, and feel hard in the ear in the oat, and prickly to the hand in the wheat, on being grasped, they are ripe. On examining the grain itself, it should feel firm under pressure between the finger and thumb, when ready for reaping; or when the neck of the straw yields no juice on being twisted with the fingers and thumbs. Barley should be of uniform yellow colour in the grain and awns, and the rachis somewhat rigid; and as long as the head moves freely by a shake of the hand, the grain is not sufficiently ripe, nor will the colour be uniform. When very ripe, wheat bends down its ear, opening the chaff, becoming stiff in the neck of the straw, and clearly indicating that nature intends that the grain shall fall out. Red wheat is less liable to be shaken than white; but any kind will shake out when too ripe, provided the plant is in good health, and the grain of good quality; for it is difficult to make immature grain leave the chaff even when hardened, and spelt wheat has so tenacious a hold of its chaff that it is difficult to disengage it even by the blows of the flail, fig. 350. It might be supposed, that when the ear and the entire straw are of uniform yellow colour, the plant is no more than ripe; but by that time the straw has ripened to the root, and the ear has rigidly bent and is ready to cast its seeds with the slightest wind. The same rule will apply to barley as to wheat. When the neck of the straw is ripe, it is time to cut, and when too ripe the ear bends itself down, diverging the outward row of awns nearly at right angles with the rachis, and the entire head is then easily snapped off by the wind. In regard to oats, the same rule applies to the straw; and when over ripe the chaff stands apart from the grain, which easily shakes out by the wind.

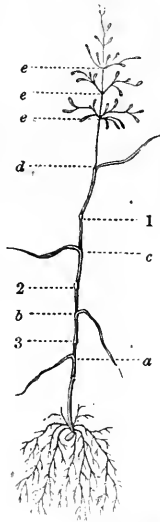
4464. It is not equally prudent to reap all sorts of grain at the same degree of maturity. When wheat is reaped too

* *Transactions of the Highland and Agricultural Society*, January 1847, p. 624.

soon, it is apt to shrink, and have a bluish tint in the sample; and when too ripe, the chaff opens from the grain, which is apt to fall out on the least wind; and some sorts of white wheat are thus very subject to fall out, even before reaching the point of maturity. Barley, when reaped too soon, also shrinks, and assumes a bleached colour. Much less loss attends the reaping of oats too soon than the other grains. In every case, it is much better to reap the crop before it is ripe, than to allow it to stand until too ripe.

4465. As regards the ripening of oats in

Fig. 390.



PROGRESS OF RIPENING
IN A STALK OF OATS.

particular, Mr Alexander Murray, Nether Mill of Cruden, in Aberdeenshire, made experiments to ascertain not merely the natural progress towards ripeness, but the state of the grain at the different stages of ripening. He could distinguish six stages. The first stage was the lowest leaf *a*, fig. 390, becoming yellow; the second when the next leaf *b* became yellow; the third when the leaf *c* turned yellow; the fourth when the uppermost leaf *d* was yellow; the fifth stage was when the parts of the stem where the panicles *e e e* are attached were still green, and the sixth and last stage was when the stem there became also yellow.

4466. The condition of the grain at each of these stages of ripeness was easily distinguished from each other, and the grains could be arranged in consecutive order. Such was the rapid change effected in the condition of the grain between the fifth and the sixth or last stage, that it acquired the additional weight of from $1\frac{1}{2}$ to 2 lb. in the bushel.*

4467. All the kinds of grain are cut down by either of the two very simple

implements, the sickle or the scythe. And first, in regard to the *sickle*. Reapers provide their own sickles, but scythes are furnished to the mowers by the farmer. As the arrangement of the reapers is different in the field when using these implements, I shall first describe the method of cutting down grain with the sickle and then with the scythe.

4468. The *sickle* is a very simple, but at the same time, as far as it goes, a very efficient instrument; and its varieties are confined to two very distinct forms, the *toothed* and the *smooth-edged* sickles. Fig. 391 represents the *toothed* sickle, an instrument so well known that it requires little description here.

Fig. 391.



THE TOOTHED SICKLE.

The blade, in the common toothed sickle, is principally made of iron, but with an edging of steel; the teeth are formed by striking with a chisel and hammer, in the manner of file-cutting, the cutting being only on the lower side; but when the blade has been bent to the proper form, tempered, and ground on the smooth side, the serratures are brought prominently out on the edge of the blade; and as the striking of the teeth is performed in a position oblique to the edge of the blade, at an angle of about 70° , the serratures on the edge acquire what is called a *hook* towards the helve, thus causing the instrument to cut keenly in that direction, when drawn through the standing corn. When the blade has been thus finished, a wooden helve, of the simplest form, is fitted upon the pointed tine formed at its root for that purpose. The toothed sickle is made with various degrees of curvature and of weight, but chiefly as represented in the figure; and it has been the subject of several patents, chiefly depending on the formation of the blade. One of these is now of some years' standing, and is an important one. Messrs Sorby and Son, of Sheffield, are the patentees; and the principle upon which their

patent is based is a blade of rolled cast-steel swedged into a form that gives a sufficient degree of stiffness to the blade, without the increase of weight that accompanies the thick-backed or the other patent ribbed-back sickles. In the new patent, the advantage of a small quantity of the very best material—cast-steel—is combined with extreme lightness and a due degree of strength and stiffness, the latter arising from the swedged or moulded back. The toothed sickle cannot cut straw until the straw is held firm, either directly by the hand, or against a handful of cut corn. Its proper use, therefore, is to cut the corn in small portions at a time. It requires no sharpening, and occasions no cessation of work. It costs 6d. or 7d. each, according to size.

4469. In the formation of the sickle, the curvature of the blade is a point of more importance than to a careless observer may appear; and though the ordinary reaper is seldom qualified to judge in this matter, he may feel pleased to be informed, that there is a certain curvature that will give to the muscles of his right arm the least possible cause for exertion, while there are other curves that, if given to the blade of the sickle, would cause him to expend a great amount of unnecessary exertion in the arm, and a consequent unnecessary fatigue would follow. Fig. 392,

Fig. 392.



THE SMOOTH-EDGED SICKLE.

representing the large *smooth-edged* sickle, has a curvature approaching very near to that which, in this instrument, may be termed the *curve of least exertion*; and throughout that portion of the sickle that performs the cutting process, it possesses this peculiar property, from the following circumstance, that lines diverging from the centre of the handle of the sickle at *a*, and intersecting the curve of the cutting-edge, all the diverging lines will form equal angles with the tangents to the curve at the points of intersection. This property gives to the cutting-edge a uniform ten-

dency to cut at every point in its length, without any other exertion than a direct pull upon the helve. Were the curvature less at any point, a pressure of the hand would be required to keep the edge to the work; and were the curvature greater at any point, or on the whole, the exertion to make the cut would be greater, as it would then become more direct, instead of the oblique drawing or *sawing* cut, which in all cases is the most effective, and productive of least resistance. This sickle is broader in the blade than the toothed kind, though in curvature it resembles it; and the chief difference lies in being ground on both sides, to form a fine and thin sharp edge. This edge is kept keen by means of a fine-grained sandstone, like a scythe-stone, fig 324, 6 inches long and an inch square, and it is only used on the under or rounded side of the sickle. The prices of these sickles are as follows, according to size:—

	No. 1.		No. 2.		No. 3.		No. 4.		
	s.	d.	s.	d.	s.	d.	s.	d.	
Common,	0	9	0	10	0	11	1	0	} each.
Patent,	1	2	1	3	1	4	1	5	

Some reapers fasten a narrow strap of leather along the handle of the sickle, in order that it may pass in an oblique direction across the back of the hand, with the view to assist the *draw* of the implement through the straws of the grain; but if the sickle be kept sharp, which every reaper ought to be able to do, such a strap is rather an encumbrance than assistance to the reaper. The sharp edge of this sickle will cut through straw with a stroke, although the straw be not held by the hand. From this circumstance it may be supposed that this is a much easier instrument to cut with than the toothed sickle; and so it really is, but the dexterous use of either instrument depends altogether on habit and practice.

4470. The harvest-field will not be properly conducted, unless a person be appointed to superintend the reapers; for to none of the reapers can such a task be deputed, as his own occupation is sufficient to occupy all his attention. The steward is the person who should undertake this duty, unless the farmer undertakes it himself. It is his duty to announce the time for commencing work, and for leaving it, as also the hours of meals and of rest. It

is his duty to restrain the impetuous, to urge the slow reaper; to keep every one in the best humour for work; to cause the ground to be neatly cleared of the crop, and the crop itself to be judiciously handled. The man who fulfils all these duties as they should be, during the entire harvest, accomplishes no easy task, either of body or mind. He should not be mounted on horseback, but be active on foot, ready to keep everything in its appointed time and order: for a single minute's loss of work, or a confused arrangement of a large band of reapers, causes a great loss of time in the gross amount of work. The farmer himself, when not superintending, may move about on horseback; but a horse is a troublesome companion to a superintendent who has to move backward and forward behind work-people in a harvest-field.

4471. Reapers are very lightly clothed. The men cast their coats at least, and many their waistcoats too. If the hat be laid aside, its place is taken by a nightcap. The women wear caps, not bonnets, and their nether garments will incommode them the less in stooping, when cutting with the sickle, if tied under the knee with the garter; but the loose petticoat is found useful in making the ends of the corn square in gathering it after the scythe. Long gowns are now in fashion, as much in the country as in the town; but the old short-gown is the most convenient dress, in every respect, for a reaper.

4472. There are various arrangements of harvest work in which the sickle is used; one of which is the *band-win* method of reaping, which I shall describe first. A band-win of reapers consists of seven persons divided into three reapers on each of two ridges, and a bandster for both ridges. The bandster must always be a man, a woman not being able for the work of binding the sheaves. The reapers may all be men, or all women, the women being able to cut down as much corn as the men; but a desirable distribution of men and women in the band-win method, is to have a man and two women on each ridge. The reason for the band-win arrangement is, that one man can bind the corn cut by six reapers, and the six reapers can cut down two acres a-day. Band-win reapers are hired for the harvest, and receive their money wages

when the reaping is finished. This system prevails to a greater or less extent over the whole of Scotland, but particularly in the Border counties.

4473. It should be made a point to select a band-win of picked reapers and

bandster to take the lead. This is necessary, both as a pattern that cannot be excelled by any other band-win, and for the quantity and the quality of the work performed. This effect may be insured by hiring the same band-win year after year. The man *a* fig. 393, makes the bands

Fig. 393.



ARRANGEMENT OF THE REAPERS IN A BAND-WIN.

from the crown of the ridge—and as the heaviest and longest straw generally grows there, he is the fittest person for taking the heaviest part of the work.

4474. The corn-band, fig. 394, is made

Fig. 394.



THE CORN-BAND READY TO RECEIVE THE CUT CORN.

by cutting a handful of corn, and dividing it into two parts, and by plaiting the corn-ends *a* of the straw together, and twisting them into a knot, as at *b*, so as the ears shall lie above the twist, away from the reaper, when the band is stretched at length upon the ground, from *c* to *c*, to receive the corn.

4475. It is the man's duty to have a band ready to lay down as soon as the one previously laid down is filled with corn sufficient to make a sheaf. In this mode of reaping, no regard is paid to the size of the sheaf; which being the case, the reapers uniformly make

the sheaves larger than they should be, even so as to render it almost impossible for the bandster to make the ends of the band meet. Bands too much filled should never be bound, as the sheaves are apt to burst in being handled, and they are too large to be easily forked about. The women, having nothing to do with the making of the bands, devote their whole time to reaping, and filling the bands with corn.

4476. On commencing to reap with the sickle, the reaper sets herself as *d*, fig. 393, setting the feet apart, in order the more easily to bow the body down. The body on being bowed down, its weight is mostly borne upon the right leg, as *e*, while the sickle reaps the standing corn before the reaper, while she gathers it with the left hand. It is the duty of the women *e* and *g*, whose hook-handles are next the open furrow, to clear the corn of that furrow as far as the furrow-brow of the ridge upon their right hand, not only because theirs is the leading ridge, but because the woman *d*, employed on the ridge to the right of *e*, cannot gather the corn in the open furrow so well with the point of the sickle, as *e* can with its rounded body. Clearing the

open-furrow being the most troublesome part of reaping, the two women *e* and *f*, or *g* and *d*, exchange places at every landing, and take the reaping of it alternately. The succeeding position of the reapers is shown at *f*, where the woman, having cut the corn from the right hand, is accumulating it in a heap with the left one, and resting the weight of the body now on the left leg. After cutting down as far as the furrow had been cleared by the preceding reaper, she lifts the severed corn partly on her sickle and partly on her left arm, as seen with *g*, and deposits it upon the band *b*, as seen on the band *h*. These are all the positions assumed by reapers while in the act of reaping. The man on making the band as shown at *a*, after laying it down on the crown of the ridge with the corn heads away from him as at *b*, then begins to cut down the corn on the crown as shown at *c*; and by the time he has reaped an armful for the band, it is time to make another band, as the women from both sides will have had enough reaped to make up the sheaf. Thus the women in a band-win each actually cut down more corn than the men, they being continually employed in reaping while he is making the bands. Such an understanding exists among the members of a band-win, that, should any difficulty occur in the reaping of both the ridges, such as a spot of corn much laid, the reaper who encounters the difficulty is immediately assisted by all her companions. Thus the band-win reap till the two ridges are cut down, when they return to the end of the field they began at, and commence upon new ridges. Band-win after band-win do the same till the entire number of band-wins are again placed, or *stented*, into their ridges, in the same order as they were by the steward at commencing the reaping of the field.

4477. It is not easy to *describe* the best mode of cutting corn with the sickle. In commencing to cut a sheaf with the smooth-sickle the body is brought low, by resting chiefly on the right leg doubled under the body, and the left one stretched out to act as a stay and a balance to the whole frame. This first position is represented by the woman *e*. The right arm is then stretched amongst the corn, and in drawing it toward you, near to and paral-

lel with the ground, the standing corn is cut, and is received and held up with the left hand on this side, and by the standing corn beside it on the other. A creeping advance is slowly made of the body towards the left, which brings it to rest equally on both legs, while successive cuts are made with the sickle; and the additional corn thus acquired is still gathered and supported by the left hand and the standing corn. The man *c* on the second ridge is seen in this the second position. Proceeding in breadth, measured by the stretch of the arm, the body comes to rest entirely on the left leg, while the right is stretched out as a balance; and this position is continued until as much corn is cut as can well be kept up by the left hand, by rolling it against the standing corn, when the whole is lifted by the hook and left hand, and placed into the band to assist in making the sheaf. The position on the left leg is seen in the woman *f*, and the woman *g* is taking the quantity cut to the band *b* lying on the ground, to help to make up the sheaf. Any uncut straws on the ground are cut, and loose ones swept by the hook amongst the standing corn.

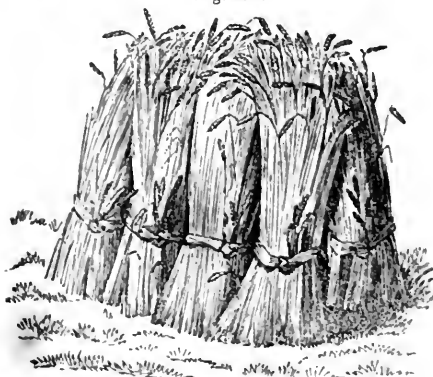
4478. The great object, in good reaping, is to make short stubble, because more straw is thereby gained to the sheaf, and less left on the field; and it is impossible to cut the stubble short, unless the body is brought as near the ground as to allow the arm to sweep the sickle parallel with it. Reapers who bow the body down from the haunches, and keep the legs upright, draw the sickle *up* towards their knees, causing the stubble to be cut in a series of notches, leaving the stubble high next them. This is bad work. In using the toothed hook, the corn is cut in small handfuls, retained firmly in the left hand, and collected in it till it can contain no more, and is then put into the band. With the body only bent forward this instrument can be easily wielded, as small handfuls can always be cut near the ground. The nearer the ground the more easily is the straw cut; but the straw cut with the toothed sickle is always too firmly squeezed in the hand.

4479. The *bandster*, as soon as one band is filled with corn, begins his operations, and he should bind the sheaves in this way:—Going to the stubble end of the sheaf,

with his face to the corn end, he gathers the spread corn into the middle of the band with both hands, and taking a hold of the band in each hand, near the ends, he turns the sheaf as much round as to place the corn end beyond his left elbow; then crossing the ends of the band, pulls as forcibly as he can, mostly with the right hand, and as close to the sheaf as possible, keeps the purchase thus obtained good with the side of the left hand, while he twists the end in the right hand, round below and behind his left hand, and then thrusts the twist under the tightened part of the band, pushing it still with the right hand, as far as to make the band keep a firm hold of it round the sheaf. After this operation, the corn end *a* of the band, fig. 394, is held firm by the pressure of the sheaf against the ears of corn and the twisted part of the band at *b*. It is requisite to attend to the position of the band in regard to the sheaf. If too near the bottom of the sheaf the lower part of the straw will be too much compressed, and the air prevented winning it; and if too near the corn-end the sheaves will spread out too much below, and be unable to stand erect. The sheaves bound up on the near ridge are carried by the bandster, as *k* fig. 393, to the far ridge upon the middle of which they are all stooked.

4480. As every two sheaves are bound they are set up as an isosceles triangle *i*, fig. 393, and four or more sheaves thus set up take the form of the stook shown in fig. 395. All the kinds of grain are now

Fig. 395.



AN ORDINARY STOOK OF CORN.

stooked in this form, for the purpose of being made quickly ready for the stack.

When the weather is good, and likely to continue so, there is no objection to this mode of stooking, particularly now, when but few weeds are allowed to grow amongst the corn, stooks require to stand in the field for a comparatively short time. Nevertheless in wet, and even damp weather, and in high situations, corn is too much exposed in such stooks, and others which afford greater security against the weather should be used. Such a form is shown in fig. 396, where two sheaves, *a*

Fig. 396.



A BARLEY OR OAT STOOK HOODED.

and its opposite, are taken by the bandster, one in each arm, and set on their stubble ends a little apart on the ground, and their corn ends brought together, in such a position on the ridge as that the length of the stook shall stand N. and S.; and these constitute the centre of the stook. Other two sheaves, *b* and its opposite, are set on one side of *a* in a similar manner, independently of, and not leaning against them; other two, *c* and its opposite, are placed in the same manner on the other side of *a*, and so on, with *d* and *e* and their opposites, until ten sheaves in a double row of five are thus set, to complete the body of the stook. A sheaf *f* is then split from the band to the corn end, and laid astride upon the corn tops of half the number constituting the body of the stook, in nearly a horizontal position, and another sheaf is placed in a similar manner with its but-end stuck into that of the other, as at *f*, upon the tops of the other half number of the sheaves, and the stook is then complete. These last inclining sheaves are called *hood sheaves*; and

are intended, by their drooping position, to ward off the rain from the corn in the body of the stook.

4481. Were the stooks of every two ridges set on the furrow-brow of each side of the central open furrow of every four ridges, the time of clearing the field of the crop by the cart would be very much expedited.

4482. The sheaves in the body of a stook are set by method. Were the corn in the knots of the bands set outwards in the stook, as seen in the nearest sheaves of the stook, fig. 395, the rain might injure it; and as it bears a sensible proportion to the corn of the whole stook, the sample might be materially injured. By simply turning the corn-knots inwards, and the root-ends outwards, as in fig. 396, such injury to the sample is easily prevented. But the corn-knots are placed uppermost in the hood-sheaves, and exposed to the rain; because, were the other side of the sheaf exposed upwards, where a groove runs down the length of the sheaf, by the straw being gathered into that form, while making the root-knot of the band, the rain might penetrate by the groove through the body of the sheaf, lying in its horizontal position, to the corn in the standing sheaves below, and would inflict a much greater injury than merely spoiling the corn-knots.

4483. Wheat stooks are seldom hooded, because they stand but a short time in the field; but stooks of barley and oats are frequently hooded, because they have to stand in the field for a considerable time; and should the weather continue wet, they will inevitably suffer if wanting the hoods. In favourable circumstances they do not require hoods any more than wheat. When stooks are completed with hoods, the wheat stook is furnished with fourteen sheaves, and that of barley and oats with twelve sheaves each.

4484. In this way a band-win of reapers will cut down, bind into sheaves, and set up in stooks, two acres of barley daily; a little less of a strong crop of wheat, and a little more of the strongest crop of oats.

4485. The advantage of the band-win system is its great efficiency in a large

number of reapers being gathered for work into a comparatively small breadth of the field, one band-win after another entering at the end of the ridge—the leading one keeping foremost, and the rest following in regular echelon order. Its disadvantages are, that a desire frequently arises for striving, or what is commonly called *kemping*, in the latter band-wins, to finish the reaping of their ridges before those who had entered theirs prior to them; the certain consequence of which is bad work, while not unfrequently resentful feelings are engendered between the band-wins. To provide against such tendencies, a vigilant superintendence on the part of the steward is absolutely requisite.

4486. Another method of reaping corn with the sickle is by the *thrave*, which simply consists of placing one person on every ridge, and paying him or her for the number of thraves cut down, by the day or week, or the harvest, as the terms of the agreement may express. A thrave consists of two full stooks of each kind of grain, the stook of barley and oats containing twelve, and that of wheat fourteen sheaves—each sheaf being three feet in circumference, or twelve inches in diameter at the band.

4487. The proper size of the sheaf is ascertained by means of a sheaf-gauge, fig. 397. This instrument is carried in the

Fig. 397.



THE SHEAF-GAUGE.

hand by the steward as a walking staff, with which he does not pretend to gauge every sheaf, but only those which seem to him to be below the mark, and which his eye easily detects after a little experience. When used, the prong of the gauge *abcd* is made to embrace the sheaf when lying on the ground, along the band, and if the sheaf just allows the points of the gauge, *a* and *b*, to slip easily down to the ground, and the band to touch the upper part of the prong *cd*, while the points *a* *b* reach the ground, the sheaf is of the requisite size, the prongs of the gauge being one foot long and one foot asunder inside.

4488. A bandster is commonly employed by the farmer to bind the sheaves and set the stooks after thravers, as these are apt to make the sheaves smaller than they should be, when they themselves bind them, and also to practise the fraud of doubling up some of the corn in the heart of the sheaf, to make the bound sheaf seem of the requisite size. When labourers are scarce, however, thravers undertake to bind and stook what they cut down, and are paid for the extra work. In order to separate every thraver's work, the corn is stooked upon the ridge where it grew; and to facilitate the carting of the stooks, they are ranged on the furrow brows of adjoining ridges. A bandster having to walk across a greater number of ridges cannot bind to so many thravers as to reapers in band-win, where his work is confined to two, so that perhaps one bandster to every four thravers may be about the proportion.

4489. After the stooks are all set on the ridges, the steward counts the number of thraves, and marks them down in a book. The thravers themselves count the number of stooks by pulling a straw from each as they walk down a long ridge to the end of the field, where they re-enter a new one.

4490. Thravers who work by the day have their accounts cast up by the steward at the end of the day's work, and paid on the spot; but they should be made to finish the reaping of every ridge entered before they are paid, otherwise confusion will ensue in the thrave-book, by having the names of different individuals on the same ridge. If any individual thraver cannot conveniently finish his ridge, he must find some friend to do it for him, to avoid this confusion, or not be allowed to enter a new, long ridge at the end of the day, but may be placed on a short one.

4491. The simplest way of reaping corn is by the thrave, and its advantages are, that the reapers are paid in money for what they cut down, and give no trouble in providing food for them. Thravers cut corn low, and make a clean stubble, as it is their interest to make up the sheaf as soon as possible, so that they seldom require to be reprov'd for bad work. The system also affords convenient occupation for the inhabitants of towns, who, by walking a

little distance into the country every day, may reap as much as they can, receive their earnings, and return home at night. It is also a convenient one for the young members of a family learning the art of reaping, under the example of a parent or friend. But it has disadvantages, inasmuch as it is the direct interest of the reaper to make very small sheaves, which materially augments the cost of reaping; and, when thravers bind and set the corn, strong temptation is placed in their power to deceive their employer in the size of the sheaf. One check over such a practice is the appointment of a bandster to bind the sheaves and set the stooks; and when he proves a sterling man, he will not bind a sheaf that is less than the proper size, and will place it before the reaper; but it is rare to find a bandster that will act in this manner, his sympathy being easily excited to favour the "poor widow," "the lone woman," or "the helpless orphan." There is inconvenience, too, in placing a large number of reapers on single ridges, inasmuch as, the different thravers having different powers of reaping, one cuts through the ridge far ahead of his next neighbour, whilst others may delay cutting out their ridges for several days. The party who passes the others are bound to clear both the furrows of the ridges. No inconsiderable trouble is imposed on the steward in counting the thraves of every ridge, and marking them down in a book, and in calculating every day's reaping of those who are hired by the day. The carting off the stooks from every ridge causes the horses to walk double the distance in clearing a field.

4492. The immediate effect of reaping with the sickle, on the state of the cut crop, particularly in thraving, is the pressing of the straw and of the sheaf together, and the loose and unconnected position given to the ears, when the sheaves are bound too near the but-end, much against the stability of the stook and of its winning.

4493. The powers of reaping by single individuals are best exhibited in thraving. I have seen more than one young woman cut twenty-four thraves of oats a-day; and many that cut twenty thraves, all good sizable sheaves—for it is the old and infirm who practise tricks in filling their

sheaves. When I mention that from eight to twelve thraves are considered a good day's work, such exertions will be better understood. In all great feats of thraving, I have found women superior to men, and more enduring for a length of time; and, with the exception of one tall blacksmith, who wielded with uncommon strength an extra-sized scythe-hook of his own making in his left hand, I never saw a man who cut the largest quantity mentioned above.

4494. Reaping with the sickle is executed in England in a manner technically named *bagging*, which is performed in this manner in Buckinghamshire:—First make a band, as in fig. 394, and lay it down; then, standing in the furrow with the left hand to the standing corn, cut a handful; put the stubble ends of this handful all even, then grasp it in the left hand eight or ten inches from the end; and with this assistant lay a little of the standing corn back, or from you, and with the *scythe-hook*; fig. 392, chop off, cutting inwards close to the ground, the corn so laid off; move the left hand forward, lay back the corn as before, and make another cut, and so proceed—moving left hand, one foot, and the scythe-hook simultaneously—across the “land” or “ridge,” or half way across it, if there are two persons on it: four to five yards being the usual breadth taken. Having reached the breadth intended to be taken, drop the corn which till now has been held in the left hand, among the cut corn which now leans against the standing corn, and commence collecting what has been cut. For this purpose, walk backwards over the same ground, or rather a little nearer the standing corn—use the left hand, the hook, and the right foot—roll over the cut corn with the hook, and at the same time cut some more with the point of it, and keep walking backwards and collecting all together till you reach the furrow from whence you started, when you will find you have got an armful. Lay this armful into the band, cut another left-handful as at first, and again go on cutting inwards; returning with the armful, lay it in the same band, which is then enough for a sheaf. Make another band for another sheaf, and proceed as before, cutting forward, and cutting and collecting backwards, clearing

about one yard wide.* In Worcestershire, bagging is executed by a tool called a bean-hook, and the straw is cut by a stroke instead of a cut of the sickle, holding or collecting the straw in the left hand. The best baggers use a wooden hook in the left hand, to collect and bring together the cut wheat in a bundle-like shape to the ground. Some reapers in Scotland practise the bagging mode of cutting corn, and use the left hand to steady the corn while it is in the act of being cut by the right. The mode is technically named *dinging-in*, or *cuffing*. A man practised in it will do one-half more work than is usually done in the common way; but the stubble is left less regular, and there is a want of tidiness in the work, even in the most expert hands.

4495. A mode of cutting corn with the sickle is practised in some parts of England by using the smooth-edged sickle, fig. 392, in cutting the straw so as to leave a high stubble, the corn being gathered under the hand, and the strokes of the sickle made as in bagging. The stubble is afterwards cut with the scythe, and carried to the stackyard. Probably this practice was originally adopted to avoid weeds being cut down along with the valuable portion of the crop, which would be the more easily win and sooner carried home without them; and they were mown with the stubble, and sometimes the stubble and they were set on fire together. It is scarcely necessary to condemn a practice which causes two cuttings of the same crop; and it is as unnecessary to observe, that the system of farming which permits the ground to be so foul with weeds as to occasion such two-handed work is reprehensible.

4496. The Hainault or Flemish scythe may be regarded as an intermediate implement between the sickle and the cradle-scythe. It is held in the right hand by a handle fourteen inches long, supported by the forefinger, in a leather loop. The blade two feet three inches in length, is kept steady in a horizontal position, by a flat and projecting part of the handle $4\frac{1}{2}$ inches long, acting as a shield against the lower part of the wrist. The point of the blade is a little raised,

* *Mark Lane Express*, August 1841.

and the entire edge bevelled upwards to avoid striking the surface of the ground. On this account the sharpening-stone is seldom used, the handle of the hook being of hard wood, used as a straik, fig. 323. Two men work best on the ridge, along a space of nine feet, which they cut down at seven or eight strokes each, and form into four sheaves. The reaping is done by pressing the back of the hook with the left hand, against the standing corn, in the direction of the wind, and by cutting with the scythe close to the ground against the standing corn, with a free swing of the right arm—less by force than by the impetus of the blade—till in three or more strokes, according to the thickness of the crop, a sufficiency is severed, which, when caught in the hook, with a portion of the standing corn against which it rests, is rolled into the form of a sheaf by the workman walking backwards, and cutting any of the standing corn caught by the hook with the point of the scythe, until he reaches the point he started from, where by gathering and keeping the heads in a line by means of the hook, closes together the but-end of the sheaf with the scythe, and then, with both, by a little adroitness, and the assistance of the foot, a perfect sheaf is lifted from the ground, and placed in the band ready for binding. It will be observed that this operation is very similar to that of the bagging executed in Buckinghamshire, and described in (4494;) the

hook, which is suspended to the wrist by a leather belt passed through a slit in the handle, acting for a similar purpose, but in a superior manner to the handful of straw held in the left hand.* By the accompanying fig. 398, an idea of the form of the Hainault scythe and its hook, and of the mode of using them in reaping corn as described, may be formed. I accompanied the Flemish reapers, Jean B. Dupré and Louis Catteau, through Forfarshire in 1825, and drew up a report of their proceedings in that county for the Highland and Agricultural Society. The impression on the farmers present was, that a saving of about one-fourth might be effected by the Hainault scythe in comparison with the common sickle; but it has not at all made, nor will it make its way into this country, since it is not equal in its work to our cradle-scythe.†

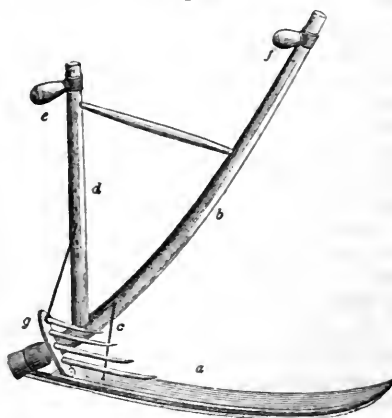
4497. The other mode of cutting corn is with the *scythe*. Scythes are mounted in various ways for the purpose, and for a considerable period has been mounted, in Banffshire or Aberdeenshire—where it is extensively used for reaping—in the form of the *Cradle-scythe*.‡ Of this form of mounting a reaping-scythe, there are many varieties; but they all agree in one point, that of having two short helves, the one branching out of the other, instead of the common long helve or sned. Fig. 399 is a view of the cradle-scythe in one of its

Fig. 398.



REAPING WITH THE HAINAULT SCYTHE.

Fig. 399.



THE CRADLE-SCYTHE FOR REAPING.

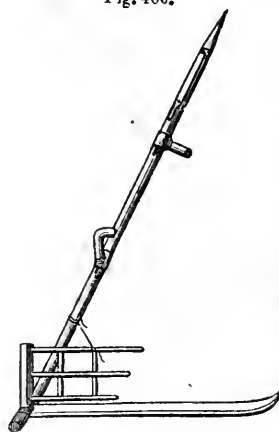
* Radcliff's *Agriculture of Flanders*, p. 121.† *Prize Essays of the Highland and Agricultural Society*, vol. vii. p. 244.‡ *Quarterly Journal of Agriculture*, vol. v. p. 106.

most approved forms, wherein *a* is the scythe-blade, three feet four inches to three feet six inches long; *b* the principal helve, four feet in length, to which the blade is attached in the usual way, the hook of the tine being sunk into the wood, and an iron ferule brought down over the tine, binding it firmly to the wood; but the blade is further supported by the addition of the light stay *c*, termed the *grass-nail*. The minor helve *d*, three feet in length, is tenoned into the former; and the two handles *e f* are adjusted by wedges in the usual way, to the height and mode of working of the mower, the distance between the helves, at the handles, being twenty-four inches. The *cradle* or rake consists of a little wooden standard *g*, about eight inches high, jointed to the heel of the blade, so as to fold a little up or down across the blade. Into this is inserted three slender teeth, following the direction of the blade, and may be from six to fifteen inches long: the head of the standard is supported by a slender rod of iron, which stretches about eighteen inches up the handle, where it is secured by a small screw-nut, capable of being shifted up or down to alter the position of the standard and its teeth to suit the lay of the corn. The standard or rake head was at one time recommended to be made in the segment of a circle,* for which there seems no good reason, either practical or philosophical; but the idea was seized upon, and the cradle-scythe, mounted in that form, was widely distributed. But instead of this supposed improvement tending to increase the favourable opinion of scythe-reaping, the practice seems rather on the decline; and there is good reason to believe, that this malformation of the rake may have had no small share in producing a distaste for scythe-reaping as a practice; whereas, under proper management, and a judicious choice of implements, there can be no doubt of considerable advantages being attainable from scythe-reaping, as compared with the sickle. In setting the blade, the following rule is to be observed:—When the framed helves are laid flat on a level surface, the point of the blade should be from eighteen to twenty inches above that surface, and measuring from a point on the left helve, three feet distant from the heel of the blade, in a straight

line, as at *b*, the extremity of the blade should be also three feet distant from the point *b*. Iron has, in many cases, been substituted for wood in the construction of the helves; but it does not, by any means, appear to be so well adapted to the purpose as the wooden helves. When constructed of iron, if they are made sufficiently light, there is too much elasticity in the fabric, which is fatiguing to the workman, by reason of the tremor produced at every stroke of the scythe.

4498. The common scythe with the straight sned, fig. 400, is mounted with a

Fig. 400.



THE COMMON REAPING-SCYTHE.

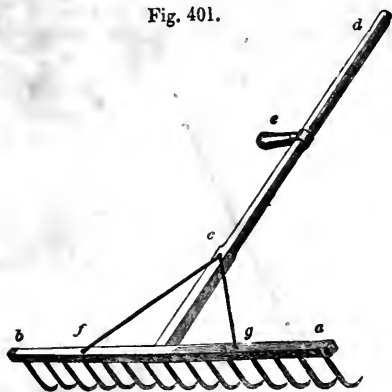
cradle for the purpose of cutting grain, and so is the common scythe with the bent sned, fig. 322. When any of the scythes are to be used in reaping, the straik, fig. 323, and the scythe-stone, fig. 324, are as much in requisition as when used for any other purpose. They should only be used as often as to keep a keen edge on the blade.

4499. Of all these varieties of form of the reaping-scythe, the cradle-scythe, fig. 399, is the greatest favourite amongst mowers, because it is found to be most easily wielded by the arms, and it causes less twist in the lumbar region of the body, which last effect is the greatest objection to all the common scythes in use. Yet it is not easy to discover why the cradle-scythe, borne by the arms alone, in front of the body, and not admitting of being balanced in one hand, like the other scythes, should be less fatiguing to the workman; but the fact is so, and in consequence more work is done with it than with any of the others.

* *Quarterly Journal of Agriculture*, vol. vi. p. 30.

4500. The gleanings of the stubble is an object of considerable value in reaping; and to secure it for the benefit of the farmer different implements are employed. The principal, and the most effective of them, is the hay horse-rake, fig. 343; but as it can only be used in the harvest field after the crop has been carried away, and after the gleanings have become deteriorated in value by exposure to the weather, the hand-rake is a more convenient implement during the reaping. Fig. 401 is a representation of this rake, which is of

Fig. 401.



THE HAND STUBBLE-RAKE.

simple construction, the form being precisely that of the hay-rake, fig. 345, but of enlarged dimensions. The head *a b* is five feet long, and should be made of good tough ash, two and a half by two inches; the helve *c d* may be six feet in height, of the same material, and furnished with a handle *e* that can be fixed in any desired position, by means of a ferule and wedge. The helve is tenoned into the head, and supported by the iron brace *f c*. The teeth are of iron, seven inches in length, and set at four inches apart, but formed in the lower part so that the bend rests on the ground, preventing the points of the teeth penetrating and mixing the earth with the gleanings. The best method of fixing the teeth is by a screw-nut, as in the horse-rake, as they are thereby easily removed in the case of being broken, without risk of injuring the head. It is also advisable to have the ends of the head hooped, to prevent splitting.

4501. Reaping with the scythe is best executed by the mowers being placed in

heads—namely, a head of three scythesmen, three gatherers, three bandsters, and one man-raker; or, what may be regarded a better arrangement, a head of two scythesmen, two gatherers, two bandsters, and one woman-raker. A larger number of heads on the latter arrangement may be employed on a large farm, while a small farm may employ one head on the former arrangement.

4502. The best beginning that can be made of a field for scythe-reaping is to mow along the ridge, parallel with the fence on the left hand, from the top to the bottom, or from the bottom to the top of the field, as the corn happens to lie; and if not laid, the inclination of the corn and the direction of the wind should both be from the right. While one head of mowers is opening up the side of the field, either from the bottom or the top, another mows either headridge at right angles to it, in the direction of the wind. Thus two sides of the field are opened up, leaving an angle of the standing corn to commence future operations upon.

4503. The first head, which should be conducted by an experienced and steady mower, commences mowing at this angle, across the ridges, as the scythes move most easily over the open furrows in that direction, laying the corn in swaths at right angles to their line of motion, upon and towards the mown headridge—the straws of the swaths lying parallel with one another, over a distance of six ridges or thirty yards, which is as far as scythes will cut straw at one sharpening. To maintain the essential requisite of laying the swaths even, the mower should not swing his arms too much to the right in entering the blade of the scythe amongst the standing corn, as he will not be able to turn far enough round to the left to lay the swath in the proper position, but will be short of the right angle. Nor should he bring his arms too far round to the left, as the swath will be laid beyond that angle: and in either case the straws will overlap each other, be difficult to separate, and their ends arranged in echelon order instead of a straight line. To lay the straw thus disarranged right in the sheaf, will waste much time and labour. He should proceed forward in a straight line, with a steady and regular motion of the arms and limbs,

bearing the greatest part of the weight of the body on the right leg, which is kept a little in advance. The length of the sweep, from the entrance of the point of the scythe into the corn until the exit of the head of the sned out of it, is from seven to seven and a half feet, and its breadth fourteen or fifteen inches. Beginners with the scythe soon learn to reap fast enough, but are defective in point of neatness;

whereas, on the contrary, beginners with the sickle soon learn to reap neat enough, grasping every portion with the hand, but are defective in point of speed.

4504. Fig. 402 shows the arrangement of the various work-people engaged in scythe-reaping, three scythemen being introduced merely to show the forms of the different sorts of scythes, and where *b b b*

Fig. 402.



THE MOWING OF CORN WITH THE SCYTHE IN HEADS.

are the three mowers forming a head, each with a different kind of scythe, laying over the corn in the beautifully square and even swaths *a a a*. The women-gatherers *c c c*, follow by each making a band, fig. 394, from the swath, and laying as much of the swath upon it as will make a suitable sheaf, as *d d*—and so carefully as to leave the ends of the band free, for the bandster to take hold of easily and quickly. The gatherer requires to be an active methodical person, otherwise she will make rough work. The bandster *e* follows her, and binds the sheaves in the manner described in (4479), any two of the three bandsters *f f* setting the stook *g* together; and in crossing the ridges, they should all be set upon the same ridge, to give the people who remove them with the cart the least trouble. Last of all comes the raker *h*, who clears the ground between the stooks with his large hand stubble-rake *i*, of all loose straws, and brings them to a bandster, who binds them together by themselves, and sets them in bundles at the

side of a stook, and not at its end, to prevent the ventilation of the air through it. This is much better than putting the rakings into the heart of a sheaf, where they will not thrash clean with the rest of the corn; and as they may contain earth and small stones, and inferior grain from straws which may have fallen down before the mowing, it is better to thrash the rakings by themselves. When the mowing and gathering are properly executed, the rakings should not exceed from four to five per cent of the crop, which is not more waste than in reaping with the smooth sickle.

4505. Every species of the cereal grains may be mown with the scythe. Many farmers still believe that the scythe is an unsuitable implement with which to mow wheat; but I can assure them, from long experience and observation, that it is as suitable as the sickle, and that mown sheaves may be made to look well, provided the gatherers are proficient at their work. Doubtless mowing wheat is severe

work, and so is reaping it. Oats are the most pleasant crop to mow, their crisp straw being easily cut with the scythe; and being smooth, and not too long, does not injure the hands in binding like wheat, and the sheaves are easily set in stook. Barley straw being covered with a gummy matter, which gives it a malty smell, soon takes the edge off the scythe, and being brittle, not hard, is easily broken in the binding. When much young grass is found among the barley straw when mown, it should be shaken out by the gatherers, while holding the straw by the corn end, as it will detain the crop too long a time in the field in winning; and rather than run that risk, it is better to incur the extra cost of getting rid of the grass by a little sacrifice of time at reaping, or even by the engagement of extra hands. It is scarcely practicable to shake out grass from corn while reaping with the sickle, as the instrument would constantly be required to be laid aside, both hands being required in the operation. To cut the stubble as high as the grass, would make the straw in the sheaf too short.

4506. A good mower will cut one acre of wheat, or perhaps rather more, a day. If a stroke of the scythe covers seven feet in length and fifteen inches in breadth, an area equal to 1260 square inches, it will take about 5000 such strokes to reap an acre. Two acres of oats may easily be mown in a day, thus indicating that a man will mow double the extent of oats he will do of wheat, or make about 10,000 strokes of the scythe in a day. Nearly two acres of barley may be mown in a day, time being wasted in the extra sharpening required in cutting barley straw.

4507. Mr John Taylor, steward at Corriestone, Aberdeenshire, gives the following as his experience of the comparative quantities of ground reaped and mown by seven persons, on an average of ten hours' work:—

	Wheat.			Oats and Barley.		
	A.	R.	P.	A.	R.	P.
By the scythe,	2	3	0	4	0	20
By the smooth sickle,	1	1	18	2	2	10
By the toothed sickle,	1	0	8	2	0	10

4508. And the average number of sheaves, of an average crop of oats and

barley that one man can bind and stook in a day of ten hours, by the three modes of reaping, he mentions as differing thus—

Of sheaves reaped by the scythe,	1500 or 62½ thraves.
.. .. smooth sickle, 1200 .. .	50 .. .
.. .. toothed sickle, 1200 .. .	50 .. .

The difference is accounted for by the bandster not having to go from ridge to ridge in following the scythe, but continues at the same row of swath. In practice, however, the bandster binds less in a day to the scythe than to the sickle, because he binds but to one scythe, but to six reapers with the sickle, who reap more than one scythe—the time of the bandster being filled up in assisting the gatherers to make bands. Mr Taylor has bound and stooked 1680 sheaves of oats, containing nineteen and a half quarters of grain cut by the scythe, and of sheaves cut by the sickle only 1360; and yet, the latter imposed upon him a decidedly harder day's work. A bandster will do more work with soft than with hard straw; and with a luxuriant than a poor crop, because he walks over less space from sheaf to sheaf, and from stook to stook.*

4509. A judicious remark is made by Mr Taylor in superintending harvest people, that in the first week, should the weather prove warm, the workers should have a rest of twenty minutes, whenever found requisite; and he adds—"I find it a plan both humane and profitable."

4510. In using the common scythe, I observe, in many parts of the country, the swath laid up against the standing corn, and is gathered while in that position. Why this mode of disposing of the swath should be *preferred* to laying it flat on the ground, it is difficult to conjecture, for not a single advantage does the method possess; while the disordered condition in which the corn is taken away by the gatherer from the standing corn, compared with lifting it up from the flat ground, is a sufficient objection to the practice.

4511. The immediate effect of mowing on the state of the corn, is to cause the straws to hook on to one another, as is evinced by the difficulty of dividing a mown sheaf when about to be passed through the

* *Transactions of the Highland and Agricultural Society, July 1844, p. 259-63.*

thrashing machine; and also to cause the corn ends of the different lengths of the straws incident to a crop to come together; and the consequence is, that the corn end of a sheaf is more crowded than the straw end—a state conducive to quick winning after mowing.

4512. One mode of setting up corn to dry quickly is in *gaitins*—that is, the band of the sheaf is tied loosely round the straw, just under the corn, as at *a*, fig. 403, and

Fig. 403.



A GAITIN OF OATS.

the loose sheaf is made to stand by spreading out the lower end of its straw in a circular form, from *b* to *c*. Gaitins are set upon every ridge; the wind whistles through them, and the rain does not hang upon but passes through them. Gaiting is only practised in wet weather, and even then, only when a ripe crop is endangered in standing by a shaking wind. It is confined to oats, wheat and barley never being gaited; because when wheat gets dry, after being cut in a wet state, it is apt to shake out in binding the gaitins; and when barley is subjected to the rough usage of binding, after being won, the heads are apt to snap off altogether: and, besides, so much exposure, as in gaitins, injures its colour, and renders it unfit for the maltster. Oats are protected by a thick husk, and the grain is not very apt to shake out in handling, excepting potato-oats, which are seldom gaited, the common kinds only being so treated. But, for my part, I would not hesitate to gait any sort of oats when

wet with dew in the morning, or even when wetted with rain, rather than lose a few hours' work of reaping every morning, or at nightfall. Gaitins, it is true, are very apt to be upset by a high wind; but after having got a set, it is surprising what a breeze they will withstand. After being blown down, however, they are not easily made to stand again, and then three of them at least are required to be set against each other; but whatever trouble the resetting should create, they should not be allowed to lie on the ground, and it will be found that a windy day wins them quickly.

4513. Rye, though not particularly specified, may be reaped or mown in the same manner as the other cereal grains. Its straw, being very tough, may be made into neat slim bands. It usually ripens a good deal earlier than the other grains; and its straw, being clean and hard, does not require long exposure in the field, and on that account the stooks need not be hooded.

4514. The scythe cuts a shorter stubble than the sickle by $2\frac{1}{4}$ inches, although a long stubble may be cut with the scythe, which is useful for a scytheman to be able to do, when the young grass is rank amongst the corn; for, in failing to use such a caution, the heart of the young clover in that growing state may be cut off, to the injury of the plant all winter.

4515. Reapers, when hired for the harvest, whether to use the sickle or the scythe, receive food, lodgings, and wages. Those who reap by the thrave receive only remuneration in money for what they reap, and no lodgings or food. The food given to reapers in the southern parts of Scotland consists of oatmeal porridge and milk at breakfast and supper, and bread and beer at dinner—fine wheaten bread, 1 lb. in weight, and a drink, besides, of half a quart of beer in the afternoon. Any of the people that go home to supper, as all cottars on the farm do, receive about 6 pecks of barley in lieu—the old firlo. In the more northern parts, the breakfast and dinner consist of 1 loaf of bread and 1 quart of beer, and the supper of porridge and milk, or bread and beer again. The bread is made of oatmeal, baked with yeast,

10 loaves from 1 peck or half a stone of oatmeal—making each loaf, when baked, 14 oz. weight. Some people cause 12 loaves to be baked from the peck of oatmeal. The meal allowed in lieu of supper to those who go home, consists of $2\frac{1}{2}$ stones of 14 lb. for the harvest, which is equivalent to 2 oat loaves each night, without beer. The food on Sunday, on many farms, consists of mutton broth, with bread and potatoes instead of beer. In England, food is seldom given to reapers, but beer always is; but instead of ale, an equivalent in money is frequently given. "We gave, in one case, 1s. 2d. per acre," says Mr Burness. "Sometimes, again, an allowance of malt or money is given for the whole period of harvest, or four weeks, termed the 'harvest month,' provincially. In some districts cider is used instead of ale. The drinking largely of ale and cider," continues Mr Burness, "is, perhaps, peculiar to the labouring population of England. The allowance made to them during harvest is no doubt well meant, and, to a certain extent, absolutely necessary; but, like all other good things, the boon has been very much abused in numerous instances. Much more importance has been attached to it, by both master and servant, than sober inquiry will justify. Hard work requires eating as well as drinking, and that of a peculiar quality."*

4516. Considerable trouble is imposed on the inmates of the farm-house, in providing and cooking food every day for a large number of reapers. The making of oat-meal porridge for perhaps from fifty to seventy persons twice a-day, morning and evening, and the distributing to each band-win bread and beer at dinner, and beer in the afternoon, are attended with much trouble, and considerable anxiety in what is done giving satisfaction to the people. Complaints may be made that the porridge is too thin, or that it has not been enough boiled; that the milk is skimmed or is sour; that the bread is not well baked; the beer not well brewed, and, perhaps, that the whole is dealt out in scanty measure. The farmer has little control over the baker and brewer; but this rule should be followed in regard to these two purveyors—namely, the bread should be distributed to the

reapers stale, that is, twenty-four hours old, and a stock of beer in barrèl laid in before harvest. A fresh supply of new-baked bread should be received every day, as also a fresh supply of beer from the brewer, which will have time to ferment and settle before it is wanted for use. In this way the bread and beer will be in the best state for use; whereas when those provisions are received as the necessity occurs, which is most commonly the case, the bread is obliged to be distributed in a warm, and the beer in a fermented state—both conditions being injurious to the health of work-people in a state of heat and perspiration. It is entirely in the farmer's own power to have the porridge properly cooked, and the milk in a sweet state for use.

4517. Another circumstance entirely in the power of the farmer himself to regulate, is giving the reapers their meals at stated times every day—regularity in this respect having a material effect in keeping the work of the field in good order; for whenever a meal arrives at the appointed hour, there will be no flagging on the part of the reapers; but should it not arrive when expected, the work is carelessly done, and the people have no heart to go on. The hours that seem to be well adapted for the appetite, and which divide the day into pretty equal parts, are, 8 o'clock in the morning for breakfast, and start again to work at 9; dinner at 1 in the afternoon, and again to work at 2. Have a resting-time of a quarter of an hour for the drink of beer at 4, and then to work till dusk—having begun at dusk in the morning in a late harvest, and at 5 in the morning in an early one. From 5 in the morning to 7 in the evening gives 12 hours of work, and 2 hours for meals, which is as long a day's work as reapers can endure for a harvest of 3 weeks, especially in warm weather.

4518. In order to keep proper discipline among the reapers, not a person ought to be permitted to leave a ridge without consent asked and obtained from the person intrusted with the superintendence; and when the food arrives, there should be no cessation of work till the word of command is given by the

* *Journal of Agriculture*, October 1849, p. 153.

superintendent, who should be guided by the watch—not disbanding the reapers till the hour of repast actually arrives, and not allowing one minute to pass beyond the hour of recommencing work. When reapers find no advantage of their own time taken, they will be less tempted to take advantage of the time of their employer; at any rate, they are then deprived of every excuse for so doing.

4519. As the farm servants in Scotland cannot attend to their own domestic affairs while attending to the harvest, all the members of their families receive food during the weeks the harvest is presumed to last.

4520. The lodging afforded to reapers is generally amongst straw in the straw-barn or outhouses. Those hired for the harvest receive two pairs of blankets, one pair of sheets, and a chaff bed and bolster for every two; and those hired for the week, one pair of blankets with plenty of straw, the same allowance of bed-clothes being given to thravers who cannot go to their own homes every night, and only on Saturday night. It is not an uncommon practice for stranger reapers, hired for the week, to purloin part of the bed-clothes allowed them, and the only check to that species of deprecation is the obligation to deliver up the clothes before their earnings are paid to them. Much inconvenience is experienced in the steadying when a large number of reapers have to be accommodated at night, so that those who can go home to their own houses are preferred. Separate apartments ought to be fitted up for the women from the men.

4521. Reapers' blankets of English manufacture cost at present, 1850, 7s. 9d. a-pair; and coarser, of Scotch manufacture, 6s. Strong twilled sheeting, fitted for the use of reapers' beds, costs 9d. a yard, yard wide, which makes each sheet of 2½ yards long, 3s. 9d.

4522. The money wages of the different classes of reapers are as follows:—Reapers with the sickle, men and women, receive 2s., and bandsters 2s. 6d. a-day. Mowers with the scythe get 3s., bandsters 2s. 6d., and women gatherers 2s. a-day. Thravers receive 3d. the thrave of two stooks of

oats and barley, and 4d. the thrave for wheat. When they bind and stook what they cut, they receive 3½d. for oats and barley, and 4½d. for wheat per thrave. In England, mowing costs 2s. 6d., gathering 1s. 6d., binding and stooking 2s., and raking 6d. an acre, in all 6s. 6d.; but heavy or lodged crops will cost 9s. an acre. The prices are the same, whether the mowing is from or up to the standing corn. In that country corn is usually cut by the piece, and when standing, reaping costs from 8s. to 10s.; when lodged, 10s. to 12s. an acre. The mowing of the stubble costs 2s. an acre more. The prices paid for wheat and oats are the same; and barley, being seldom bound up and stoked, is mown for from 2s. to 2s. 6d. an acre. In Scotland it is not unusual to give a slump sum for the harvest, irrespective of the number of days it may last; though three weeks are understood to be the duration of harvest. When it ends before that period, it is conceived the harvesters have gained an advantage, and so does the farmer, in the shortness of the harvest; and when it exceeds that time, the reapers conceive they incur a loss, as also does the farmer in a double sense—in the protracted harvest, which is never favourable to him, and in the extra food given to the reapers. The slump sums are to the reaper £1, 16s., the bandster £2, 5s., and the mowers £2, 14s., besides food.

4523. Harvesting is very seldom undertaken by the acre in Scotland; and, on the other hand, in England the practice is quite common, and piece-work is undertaken by men who work singly. The advantage to the mower or reaper is, that he may have his family with him; and to the farmer, he can easily inspect the work done. These advantages are also attendant on the system of thraving. In England, four weeks are regarded as the "harvest month."

4524. Taking the price of bread and oatmeal as they are in 1850, and as they are likely to be from that time forward, at 1d. per lb. for oatmeal, and 1¼d. per lb. for white wheaten bread, the cost of the food of harvesters will be as follows:—10 loaves out of 1 peck of oatmeal, gives a weight to each loaf of 11·2 oz. of

oatmeal, and oatmeal at 1d. per lb. fixes the value of the loaf at 2·8 farthings. The cost of baking with yeast being 1 farthing per lb. of oatmeal, including yeast and salt, the baking of one loaf of 11·2 oz. increased with yeast, salt, and water to 14 oz., will be 0·7 farthing. Each oatmeal loaf baked with yeast will thus cost 2·5 farthings = 2½ farthings. Thus at

1 loaf to each harvester at breakfast,	2½ farthings
1 dinner,	2½ ..
2 supper,	5 ..

Making the daily expense in bread at 10 farthings = 2½d.
To which add 2½ quarts of beer to each harvester at breakfast and dinner, at 1d. per quart, } 2½d.

Making the daily cost for bread and beer of each harvester, 5d.

With loaf bread at 1¼d. the loaf, the cost of each harvester with beer would be 7½d. Oatmeal porridge and milk at breakfast and supper, the milk being a half quart each meal to every person, would reduce the price below that of bread and beer of any kind; but how much I do not know, as I have never observed it ascertained how much meal is consumed by each harvester in porridge.

4525. The food of a band-win of reapers, of six reapers and one bandster, at 5d. each for oatmeal, and 7½ for loaf bread,

	Oatmeal.	Loaf bread.
	s. d.	s. d.
Costs per day,	2 11	4 4½
Wages of 6 reapers at 2s. per day, or 12s. per week, } Wages of 1 bandster at 2s. 6d. per day, or 15s. per week, }	12 0	12 0
Making the daily cost } of a band-win, }	2 6	2 6
	17 5	18 10½

Taking 2 acres of wheat, barley, and oats overhead, as a fair extent of harvest-work, for a band-win, the expense of reaping at 17s. 5d. a-day is 8s. 8½d. an acre, and at 18s. 10½d. a-day, 9s. 5¼d. an acre. On reaping the respective kinds of grain, barley would cost the sums stated, wheat a little more, and oats a little less. At the reduced wages of 10s. the week for reapers, and 12s. 6d. for bandsters, the cost would be 7s. 6d. and 8s. 2¾d. an acre for barley, and a little more for wheat, and a little less for oats.

4526. In mowing, the food of 3 mowers, 3 gatherers, 3 bandsters, and one raker, = 10 persons at 5d. and 7½ each,—

	Oatmeal.	Loaf bread.
	L. s. d.	L. s. d.
Costs per day,	0 4 2	0 6 3
Wages of 3 mowers at 3s. a-day,	0 9 0	0 9 0
.. 3 gatherers, at 2s.,	0 6 0	0 6 0
.. 3 bandsters, at 2s. 6d.,	0 7 6	0 7 6
.. 1 raker, at 2s. 6d.,	0 2 6	0 2 6
	£1 9 2	£1 11 3

	s. d.	s. d.
Thus 6 acres of oats cost per acre,	4 10½	5 2½
.. 5 .. barley,	5 10	6 3
.. 4 .. wheat,	7 3½	7 9½

With the wages reduced in the proportion mentioned above, the cost would be reduced to the following sums per acre:—

	s. d.	s. d.
For oats,	4 2	4 6
.. barley,	5 0	5 5
.. wheat,	6 3	6 6

It should be observed that the prices of the articles of food mentioned in (4523) are estimated at the market value, which is beyond what it costs the farmer to raise them, and that being the case, the cost of harvest-work is here represented fully above the mark.

4527. I have repeatedly ascertained that *thraiving* never costs less than 12s. an acre, including the wages and food to the bandsters.

4528. It will be observed, from the foregoing statements, that mowing is much the cheapest mode of reaping corn, on which account it should be universally adopted, as harvest expenses form a heavy item in the farmer's books, and every available means should be used to lessen them. Any plan that would deprive the ordinary dwellers of a farm of work, I would hesitate to recommend; but when the farmer is obliged to go into the public market of labour to procure assistance in cutting down his crop, he is justified in relying, if possible, on his own resources. It is scarcely practicable for him to do so, without throwing his horses idle for a long time; and as no economy is found in such a course, the only alternative left him is to economise the cost of harvest-labour. Now, the scythe is both an economical and efficient implement, and whoever has used it has never relinquished it. A prejudice at first existed against it, on account of a mown stook not looking so trim as a reaped one, and of the difficulty of building a neat stack with mown sheaves. There is roughness in the appearance of mown sheaves, but it is not at all

detrimental to the corn, and would not even seem unsightly, were mowers careful to lay the swaths at *right angles to their line of motion*, as by *b*, fig. 402; were gatherers to lift the swaths with both hands meeting, as seen at *c*; lay the armfuls even in the bands, as shown at *d*. Although it is difficult for work-people to bestow their utmost attention constantly on their work, yet practice makes proficiency in this manner of harvesting, as I have found to be the case, after having employed the same hands at it for successive years.

4529. Besides economy, mowing enables the corn to be carried, after it has been exposed in the air to win, in half the usual time. Reaped oats must stand in the stook a fortnight ere they will keep in the stack; mown oats, in similar weather, may be carried in a week. Barley, when reaped, is not fit to lead in less than three weeks; when mown, it may be stacked in safety in ten days. Mown wheat will carry in three days.

4530. It is an error to believe that a mown stook takes in rain; on the contrary, I have frequently ascertained that it takes in rain less than a reaped one. In one remarkable instance, I remember a field of potato-oats on being finished in cutting, that heavy rain fell the next day, and continued, without intermission, for three days, the last of which was very windy, and when the wind changed from E. to W. it faired. About one-third of this field had been reaped with the sickle, and the reason that implement was used in it at all was to give a little harvest-work at thraving to a few elderly men and women, cottars and hinds' wives, who, having to attend to young children, could not undertake the regular work of a harvest-field. Impressed with the common belief, that mown sheaves must take in rain, I went to the field after the rain had ceased, to ascertain the state of the stooks, never doubting they would be soaked, while the reaped ones would be comparatively dry; but the fact was the very opposite, none of the mown sheaves being wetted to the heart, while the east side of the reaped ones were soaking to the bands. On consideration, I accounted for the difference in this way:—In reaped sheaves, and

especially when cut by thrave, the straws are straight and hard pressed, between which the rain finds its way into the heart of the sheaves; while the straws in the mown stooks, being somewhat bent and broken, and interlaced on the surface, form a texture which prevents the rain penetrating, and rather serves to throw it off. Besides this property, mown sheaves are more pervious to the air than reaped ones.

4531. An advantage of another kind obtained in mowing corn, is the very short stubble left in the field, and the larger quantity of straw carried to the stack-yard. The following statement may be depended on, as being the result of experiment:—

Weight of straw per acre, when cut to

	Cwt.	qr.	lb.
2 inches of the ground,	26	1	0
8 	23	1	6
12 	21	0	2

So that a half cwt. of straw is left per acre with every inch of stubble. When we know that the value of straw is about 28s. per ton. (15s. per load of 36 trusses,) we cannot but feel surprised at the barbarous mode of using the wheat-straw in some places of England, by bagging, (4495,) in first reaping the ears of corn and then mowing the straw.

4532. The proportion which the straw and grain bear to each other cannot be stated with sufficient accuracy. I have received the following statement of their relative weights in the neighbourhood of Edinburgh, from Mr Andrew Gibson of the Dean Farm, whose superior farming is well known:—From a crop of wheat, of 40 bushels to the acre, or of 2600 lb., at 65 lb. per bushel, the straw will weigh 9 kemples of 440 lb. each, or 3960 lb., affording just one-half more weight of straw than of grain. From a crop of barley of 60 bushels, weighing 56 lb. per bushel, or 3360 lb. per acre, the weight of straw is 7 kemples, or 3080 lb., being one-tenth of less weight of straw than of grain, (1911.) From a crop of 60 bushels of oats, at 45 lb. per bushel, or 2700 lb. per acre, the weight of straw is 8 kemples, or 3520 lb., being one-third more weight of straw than of grain. These are all average quantities. In ordinary

crops at a distance from towns, the proportion is about double the weight of straw to the grain.

4533. Mr M'Lagan younger of Pumpherton, in Mid-Lothian, kindly made some experiments for me on the relative proportion of grain and straw, and the following are the results obtained in 1849. Of four experiments with oats *dibbled*, the average weight of grain per acre obtained, was 3479 lb., and of straw and chaff 7260 lb., or more than double the weight of straw to the grain. Of six experiments with oats *drilled*, the average weight of the grain was 2974 lb. per acre, and that of the straw and chaff 5836½ lb., being less than double the weight of straw to the grain. Of four experiments with oats sown *broadcast*, the grain weighed per acre 3176¼ lb., and the straw and chaff 6428½ lb., or rather more than double the weight of straw to the grain. Double the weight of straw to the grain may thus be regarded as near the truth, at a distance from large towns, while in their immediate neighbourhood the grain bears a larger proportion to the straw.

4534. Connected with the proportions of the different parts of the same crop, is the relation which the stubble and roots left in the ground bears to the straw and grain carried off it. Mr M'Lagan's experiments enable me to state this relation in reference to oats sown broadcast, drilled, and dibbled; and the results, which might have been expected to be various, are surprising and anomalous. Thus—

DIBBLED.

Plants in a square yard.	Weight of straw and chaff on an acre.	Weight of stubble and roots on an acre.
	lb.	lb.
26	6050	19,360
49	8470	27,830
75	4840	29,040
120	9680	10,588

Here extraordinary differences may be perceived between the case where 75 plants grew upon the square yard, the stubble and roots weighed six times the weight of the straw and chaff; and that where 120 plants grew in a similar space, the straw and chaff, and the stubble and roots, were nearly equal in weight.

* Johnston's *Lectures on Agricultural Chemistry*, 2d Edit., p. 746.

4535. DRILLED.

Plants in a square yard.	Weight of straw and chaff on an acre.	Weight of stubble and roots on an acre.
	lb.	lb.
32	5445	18,150
53	7260	37,510
78	4235	14,520
94	6656	14,520
140	5748	12,100
208	6050	17,244

With the exception of the case of 53 plants to the square yard, which yielded five times of stubble and roots to the straw and chaff, the differences in the relation of the straw to the roots is not material, being 1 to 2 and 3.

4536. BROADCAST.

Plants in a square yard.	Weight of straw and chaff on an acre.	Weight of stubble and roots on an acre.
	lb.	lb.
19	3932	13,330
52	6050	20,570

Here the difference between the straw and roots is again about 1 to 2 and 3. Professor Johnston mentions that, according to the experiments made by Hlubek in the agricultural garden at Laybach, the sheeps-fescue and perennial ryegrass left of roots in the soil three times the weight of the hay produced in the same year; and in old pasture the roots are four times as heavy as the hay yielded by it. Even after the roots had been thoroughly dried, they weighed half as heavy again as the crop.* The results of the foregoing tables indicate that the roots are from 2½ to 3 times heavier than the straw of the oat, with some surprising exceptions.

4537. These same data afford us the average gross weight of the produce of the entire oat crop from the comparatively small weight of the whole of the seed sown. Thus:—

Dibbled.	{	Grain,	3479	ton. cwt. lb.
		Straw and chaff,	7260	
		Stubble and roots,	21,704	
			32,443 = 14 9 75	
Drilled.	{	Grain,	2974	
		Straw and chaff,	5836	
		Stubble and roots,	19,007	
			27,817 = 12 8 41	

Broadcast.	{	Grain,	3176	ton. cwt. lb.
		Straw and chaff,	6428	
		Stubble and roots,	11,450	
		<u>21,054</u> = 9 7 110		

It thus appears that dibbling raised the largest weight of crop from the smallest weight of seed, and broadcast the smallest weight of crop from the largest weight of seed, in about the proportion of 14 to 9.

4538. These results were obtained by weighing the stubble and roots as they were taken out of the ground and only deprived of their earth. M. Boussingault made experiments of a similar character on the stubble and roots of wheat, oats, and clover of crop 1839, dried in the sun and air, and their weights per acre were as follows:

Wheat stubble and roots,	5½ cwt.
Oat,	8 ...
Clover,	15½ ... *

4539. In prosecuting the experiments instituted by him to an end, Mr M'Lagan obtained the results desiderated in (3532,) which were the amount of produce in grain, and that was as follows in oats:—

DIBBLED.

Plants in a square yard.	Number of grains raised in a square yard.	Weight of grain on an acre.	Number of bushels of 40 lb. per acre.	Increase in fold.
26	7,500	lb. 2724	68	288
49	11,700	3859	96	240
75	5,400	2118	53	72
120	...	5294	132	..

The largest return, 16½ quarters an acre, specified in these tables, is when 120 plants occupied the square yard from dibbled seed; and the smallest return, 6½ quarters an acre, is also recorded with dibbled seed when 75 plants occupied the square yard—which last result is equalled from 19 plants occupying the square yard from seed sown broadcast: the 19 plants thus yielding four times in fold that the 75 did, as may be observed in comparing the columns of the increase in fold in both the cases. We cannot explain whence such discrepancies arise. The returns in general, exhibited in the tables, are greater than what is commonly received, as one might expect would be the case, where experiments are conducted with more care than ordinary culture, and all the produce is carefully preserved; whereas much waste is occasioned from an ordinary crop passing from one hand and process to another, before the ultimate result is ascertained. Such comparisons, however, should inculcate carefulness in all the operations connected with the field-culture of every crop.

4542. As regards these results, Mr M'Lagan truly remarks that they "are most capricious;" and judiciously observes that "there is one thing that strikes me as curious and interesting—namely, the great preponderance of pickles reaped when only 2 pickles were put into the hole, compared to the result when 3 were put in. One pickle in a hole gave a much better yield than three. Might we not argue from this, that, if dibbling is to be much practised, it will be better to make more holes, and put fewer seeds into each hole? There is some confirmation of this from the results obtained from broadcast, where there is a gradual increase of produce according to the quantity sown—owing, I suppose, to the seeds being more equally distributed over the ground."

4543. "The rest of the field," continues Mr M'Lagan, "not experimented on, was sown the same day as the parts on which the above observations were made at the rate of 4½ bushels to the acre. It was in full ear on the 9th and 11th July, and was reaped on the 8th of September.

4540. DRILLED.

Plants in a square yard.	Number of grains raised in a square yard.	Weight of grain on an acre.	Number of bushels of 40 lb. per acre.	Increase in fold.
32	7,500	lb. 3025	75	234
53	7,900	3632	91	150
78	5,600	2420	60	72
94	6,900	3025	75	73
140	...	2875	71	...
208	...	2875	71	...

4541. BROADCAST.

Plants in a square yard.	Number of grains raised in a square yard.	Weight of grain on an acre.	Number of bushels of 40 lb. per acre.	Increase in fold.
19	5,100	lb. 2117	53	270
52	8,000	3113	78	154
68	8,700	3632	91	128
87	...	3632	91	...

* Boussingault's *Rural Economy*, p. 486-7—Law's translation.

I also sowed some at the rate of $2\frac{1}{2}$ and $3\frac{1}{2}$ bushels to the acre. It was also a good crop, and was nearly as soon ready for reaping as the rest of the field. I made several observations about the time the corn came into ear, and found that it came into ear according to the thickness of sowing, the thickest sown being first in ear, and the drilled portion being always the most forward. The thinnest sown had strong straws and magnificent heads, but I was obliged to cut them before they were ripe. Although several parcels were cut on the same day they were not equally ripe, the thinnest sown always being greenest."

4544. In continuation of the experiments recorded of Mr Hay of Whiterigg, in (3533) and (3534,) he obtained the following results in yield of straw from dibbled and drilled grain respectively. Thus, from—

WHEAT.

Dibbled in one square yard.

Seeds sown.	Seeds braided.	Stalks cut.	Increase of stalks by tillering.	
144	97	330	235 = 3.40 times.	
432	296	439	143 = 1.48 ..	
864	616	614	.. = none. ..	
Average,	480	336	461	188 = 1.37 ..

Drilled in one square yard.

144	105	343	238 = 3.26 ..	
432	327	507	180 = 1.55 ..	
864	652	680	28 = 1.04 ..	
Average,	480	361	510	149 = 1.41 ..

4545.

BARLEY.

Dibbled in one square yard.

144	95	330	235 = 3.47 ..	
432	335	688	333 = 1.99 ..	
864	687	1002	315 = 1.44 ..	
Average,	480	372	668	294 = 1.79 ..

Drilled in one square yard.

144	86	690	594 = 7.90 ..	
432	318	934	616 = 2.93 ..	
864	747	1225	478 = 1.64 ..	
Average,	480	384	946	563 = 2.46 ..

4546.

HOPETOUN OATS.

Dibbled in one square yard.

144	129	588	459 = 4.55 ..	
432	403	806	403 = 2.00 ..	
864	800	1092	292 = 1.36 ..	
Average,	480	444	829	385 = 1.86 ..

Drilled in one square yard.

Seeds sown.	Seeds braided.	Stalks cut.	Increase of stalks by tillering.	
144	139	578	439 = 4.15 ..	
432	408	854	446 = 2.09 ..	
864	798	1132	334 = 1.41 ..	
Average,	480	448	855	406 = 1.90 ..

4547.

POTATO OATS.

Dibbled in one square yard.

144	135	603	468 = 4.46 times.	
432	407	821	414 = 2.01 ..	
864	823	915	92 = 1.11 ..	
Average,	480	455	780	345 = 1.71 ..

Drilled in one square yard.

144	137	540	408 = 3.94 ..	
432	407	711	304 = 1.74 ..	
864	795	798	3 = 1.00 ..	
Average,	480	446	683	237 = 1.53 ..

4548. These figures instruct us that, where the seed is sown thin, the disposition of the plant to tiller increases; which shows that the soil endeavours to support a definite proportion of plants, according to its ability as regards its state of fertility. We see that, where the seed is supplied so scantily as 144 to the square yard, or 696.960 to the acre, which is about 1 bushel to the acre, (1856,) that the tillering in the wheat plant takes place to the extent of about $3\frac{1}{3}$ times the plants braided from the seed; in the barley plant from $3\frac{1}{2}$ to 8 times; and in the oat plant about $4\frac{1}{4}$ times. At 2 bushels of seed to the acre, the tillering of wheat is $1\frac{1}{2}$ time more than the plants braided; of barley from 2 to 3 times; and of oats about 2 times. With 3 bushels of seed to the acre, wheat tillers scarcely at all; barley about $1\frac{1}{2}$ more than the plants braided; and oats about $1\frac{1}{4}$ more than the braided. The average tillering in all the instances of wheat is about $1\frac{1}{4}$ to the braided; of barley about twice the braided; and of oats about $1\frac{3}{4}$ time more than the braided. If any conclusion can be drawn from the foregoing statements, it appears to be this,—that as thick sowing brings the crop sooner to maturity, it is best adapted for a cold, late season; and as thin sowing retards the ripening of the crop, it is best suited to a fine season. The character of the season must be taken as that presented at the time of sowing, and the judicious farmer will proportion the quantity of seed to be sown accordingly. The

yield of grain in the above experiments were not ascertained, as both the wind and birds had destroyed a large number of the heads, and in consequence rendered the results uncertain.

4549. On the 28th of September 1849, Mr Hay manured an undrained cold clay field with 24 tons per acre of farmyard manure, and dibbled in on one part of it four tenths of a bushel of Hunter's Imperial Hopetoun wheat per acre upon ribs, at 4 seeds to the hole, at a cost of 5s. 7½d. per acre; and on another part of the same field, treated in the same manner, he sowed on the same day, broadcast, 1 bushel 5½ tenths of the same seed, at a cost of £1, 1s. 6½d. per acre. On the 6th of June 1850, the dibbled wheat measured 3 feet 8 inches in height including the roots, and afforded from 14 to 21 thick strong stalks from each hole. The broadcast measured 3 feet 4 inches of height, including the roots; the stalks were smaller; and 21 of them weighed one eighth of an ounce less than the same number of the dibbled from one hole. On the 15th of June, both lots of wheat were in the ear.

4550. A crop of wheat varies by soil, situation, and season, from 20 to 56 bushels an acre; and the weight varies from the same causes from 59 lb. to 68 lb. the bushel, (1856.)

4551. Barley varies in produce by the same circumstances, from 36 to 60 bushels an acre; and its weight from 50 lb. to 59 lb. the bushel, (1911.)

4552. The yield of oats varies in similar circumstances even more than wheat or barley, from 30 to 90 bushels an acre; and its weight from 38 lb. to 48 lb. the bushel, (1930.)

4553. It is as easy now, 1850, to raise 32 bushels of wheat on an acre, as it was 30 years ago to raise 24 bushels; to raise 54 bushels of barley as it was to raise 42 bushels; and to raise 60 bushels of oats as it was to raise 48 bushels.

4554. In like manner, it is as easy to raise now, wheat of the weight of 65 lb. the bushel, as it was then to raise it at 63 lb.; barley now of 56 lb. the bushel as it was

then of 53 lb.; and oats now of 43 lb. the bushel as it was then of 40 lb.

4555. These results have been realised in the course of years, not so much from the superior as from the inferior classes of soils. The latter have increased more in fertility in that time than the former, and they became so entirely from ordinary good farming, and before the introduction of the special manures.

4556. Farmers neglectful of weeding their corn give reapers much uneasiness, and waste much time, while getting rid of large weeds, some of which often injure the hands of both reapers and gatherers very seriously. Of these the corn dead-nettle, *Galeopsis tetrahit*, is dangerous, causing swellings, heat, and pain in the hands; as also the biennial spear-thistle, *Cnicus lanceolatus*, the spines of which breaking in the flesh, inflict acute pain when touched, and are exceedingly troublesome to extract. The only safeguard against such accidents is the wearing of gloves made of sheep-skin, called *shearers' gloves*, which only cost 1s. the pair; but it is more pleasant for the work-people when the corn is so free of weeds as to dispense with gloves.

4557. It is in reaping a field, as in ploughing it, that short ridges waste much time in passing from one end of them to the other; and frequently much time is also lost in going from one field to another. It tends to economise time, when an acre or so of a field happens to be left uncut, after all the band-wins have completed their stented quantities, to take the troop of reapers at once to another field than remain in the one they are in to finish the small portion left, which can be cut up by the part of the binds' families who cannot undertake regular harvest-work. Should such a portion be left at the end of a day's work, it is most economical to work a little longer and faster to complete the field before leaving it for the evening; but if found impossible to complete it, the reapers should not return to it in the morning, but proceed to a new field, and leave the remnant to be reaped by the odd hands I have mentioned.

4558. Harvest generally commences

with the reaping of the winter wheat, which may be expected to be effected by the end of July in England, and the middle of August in Scotland. During my recollection the harvest commences earlier in Scotland than it did, when the beginning of September was the usual period. Beans are never ready for the sickle until all the cereal grains have been reaped.

4559. That one period of their age is better than another for reaping grain crops has been proved by careful experiments, made by Mr John Hannam, North Deighton, Yorkshire. Without entering into their details, I give only their results. Of wheat reaped at various ages, the following were the advantages and disadvantages derived :—

No. 1, reaped *quite green* on 12th August, and stacked 26th August, gave a return of L.11, 17s. per acre.

No. 2, reaped *green* on 19th August, and stacked 31st August, returned L.13, 6s.

No. 3, reaped *raw* on 26th August, and stacked 5th September, returned L.14, 18s.

No. 4, reaped *not quite so raw* on 30th August, and stacked 9th September, returned L.14, 17s. 4d.

No. 5, reaped *ripe* on 9th September, and stacked 16th September, returned L.13, 11s. 8d. per acre. Hence,—

A loss of £1 14 8 per acre on No. 1 compared with No. 5.			
.. 0 5 8	.. No. 2	..	No. 5.
A gain of 1 6 4	.. No. 3	..	No. 5.
.. 1 5 8	.. No. 4	..	No. 5.
.. 3 1 0	.. No. 3	..	No. 1.

4560. Wheat reaped a *fortnight* before it is ripe gives an advantage on every point, namely :—

In weight of gross produce, of	13½ per cent.
.. equal measures, nearly	2½ ..
.. equal number of grains, nearly	2½ ..
In quality and value, above	3½ ..
In weight of straw, above	5 ..

Other advantages are, straw of better quality, a better chance of securing the crop, and a saving in securing it.

4561. On the other hand, wheat, reaped a *month* before it is ripe, gives an advantage of twenty-two per cent in weight of straw compared with the ripe, but suffers disadvantage in every other point, namely :—

In weight of gross produce, of	11 ⅓ per cent.
.. .. equal measures, above	1½ ..
.. .. equal number of grains, above	13½ ..
In quality and quantity, above	½ ..

4562. Some of these may seem trivial advantages and disadvantages when confined to the area of a single acre; but when computed on the extent of ground under wheat culture in the kingdom, the results are striking, as exemplified by Mr Hannam,—“When we consider that there are in England and Scotland about 4,000,000 acres of wheat grown annually, producing 12,000,000 quarters of grain, of which three-fourths are

allowed to become ripe; when we consider that by cutting this sooner we should produce an increase of 15½ per cent of flour, and realise an increased value of 7s. 6½d. upon every quarter produced; and that we should produce food for 1,362,857 persons over and above what we now produce, and an extra annual income of L.512,491, and when we consider that this increase would be so much added to the wealth of the country, that it is equal to the proceeds, at three per cent, of an estate worth L.17,083,033; and that the increase of our population demands an increased supply of food, I would ask, what is our duty in this case ?” *

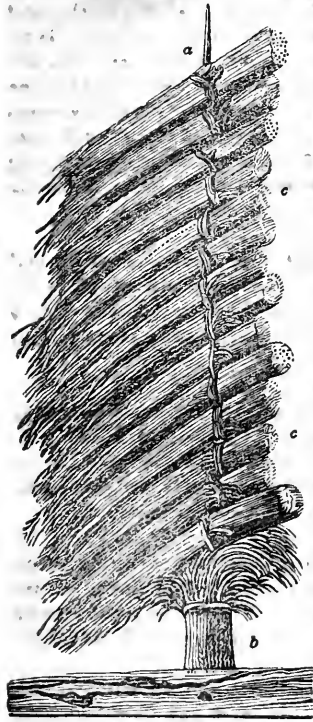
4563. Upon one occasion I cut down a few stooks of potato-oats when quite green, though full in the ear, to allow carts to pass to a place destined for the site of a hay-stack, and after standing till the rest of the field was brought in, they were thrashed with the flail by themselves, and the sample produced was the most beautifully silvery grain I ever saw; but not having made the experiment with any view to improving the crop, I pursued the investigation no farther, and cannot say what effect would have been produced upon the quality and quantity of the meal.

4564. There are various ways of stooking or shocking corn besides those represented in figs. 395 and 396. In Ireland, a safe plan against wind and rain is practised in clustering the standing sheaves with their tops close together; and after placing two hood-sheaves almost in a perpendicular position, with the stubble end uppermost, these are lashed together by a wisp from one hood being passed under the band of the other. Stooks are also set, with the standing sheaves in the form of a cross, across an open furrow or sheugh, and covered with four hoods meeting with their but-ends in the middle.

4565. In Germany the rye is stooked in a substantial and elegant form. The sheaves are all made as large as a man can only carry one. In forming the stook, one sheaf is set up having two bands, and around it in a circle, a little asunder, are placed eight sheaves with their heads meeting together, and one large sheaf acts as a hood to the others. The hood sheaf is prepared in this way :—It is placed on its but-end upon the ground, and the straw is broken down at the band from the outside of the sheaf to the centre, and arranged in a circular form, after which the sheaf is lifted by two men, who place the circularly spread out straws as a thatching over the heads of the standing sheaves, with its but-end projecting upwards. The straws are then neatly trimmed around the stook, making them cover every sheaf equally, and reaching nearly to the bands of the standing sheaves. Such a stook will ward off any quantity of rain, and resist any force of wind. In eight days the rye is ready to be carried, but it lies broad-band upon the ground several days before being thus bound into sheaves and stooked.

* *Quarterly Journal of Agriculture*, vol. xii. p. 22—37; and vol. xiii. p. 170—87.

4566. An effectual way of keeping sheaves dry and exposing them to the air is practised in Sweden, by thrusting the end of a small pole six or seven feet long, *a*, fig. 404, into the ground; and after impaling one sheaf *b* upon the stake, with its but-end standing on the ground, others *c c c* are spitted upon the stake at the bands, parallel to and above each other, till the stake is filled—the sheaves inclining with their heads downwards, to throw off the rain. This plan has been tried in this country by Mr Boswell Irvine of Kingcausie, in Kincardineshire, with success; and I should conceive, in fields surrounded with woods, and where larch weedings are abundant, the plan an excellent one for winning the corn well and fast.



THE SWEDISH STOOK.

4567. To instance an opposite extreme, the barley in the south of England is never stooked at all, but left on the ground as mown in swaths to win, and carted home to a large barn like hay—a more slovenly and objectionable mode cannot be imagined, of treating so delicate a grain for colour, and one so easy to germinate as barley.

4568. I shall not say much on *reaping machines*, as none have yet been generally used in this country. The first one was presented to public notice by the late Mr Smith of Deanston in 1814 or 1815, and afterwards exhibited in an improved form in 1837.* This machine cuts the grain by a circular disc, and gathers it in a continuous swath on the left hand with a revolving drum. It requires horse power, and a man to manage the horse and machine.

4569. The next one was produced by the Rev. Patrick Bell, present minister of the parish of

Carmylie, in Forfarshire, in 1827 or 1828. It clips the straw by a series of scissors, and places the cut straw upon an endless web, which deposits it on the right or left hand in a continuous swath. It also requires horse power and a man to manage.

4570. The next machine, as to its time of exhibition, in 1832, was that of Mr Joseph Mann, Raby, near Wigton, Cumberland. The cutter is a disc of a regular polygon of twelve sides, and the gatherer a revolving drum with rakes, from the teeth of which a comb strips the straw, which then drops at one point of the machine in a continuous swath. It requires horse power, and a man to guide.

4571. The country where the reaping machine is most in use is in the western counties of the United States of America. There the large fields of wheat, in the prairies, are obliged to be reaped with machines, manual labour being too scarce, and in consequence too dear to secure the harvest. The greatest varieties in the form of this machine may therefore be observed, and are in use, in that country.

4572. No doubt exists but that the reaping machine can cut down a grain crop at a cheaper rate per acre than any implement used by the hand of man; but, beyond the mere cutting, the gathering, binding, and stooking will still have to be accomplished by labourers. Even including the binding and stooking, Bell's machine has proved that corn may be cut down by it for 3s. the acre. Such a machine is expensive to purchase—not less, perhaps, than L.30—and more than one will be required on a large farm; yet their original cost may be redeemed, by economy in time and labour, in the course of a few years.

4573. As to the extension of the use of the scythe, Mr Taylor is justified in believing that "the practice of mowing grain is slowly gaining ground, and will in all probability continue to do so until it be universally adopted. In the north-eastern districts of Scotland, the scythe has been in general use for upwards of twenty years; and numerous are the individuals of my acquaintance who have had twenty harvests reaped by the sickle before the scythe was introduced, and who are now as clearly convinced that mowing is an improvement in reaping, as the wooden two-horse was an improvement on the twelve-oxen plough of their fathers."

4574. A curious statement was made at the council meeting, in March 1850, of the English Agricultural Society, by Mr Dyer, to the intent that, for the last ten years, he had observed that a remarkable correspondence existed in his crops between the number of grains of wheat in the ear, and the number of bushels of wheat on the acre. Thus, in his crops the average number of grains in the ear had been twenty-eight, while the bushels per acre produced had also been twenty-eight. He did not mean to express

* *Prize Essays of the Highland and Agricultural Society*, vol. x. p. xi. Preliminary Notice.
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his belief that this was a general law, but merely referred to it as a curious circumstance occurring within his own observation. At the first consideration of this remarkable statement, general experience would seem to support it; for it is known that a thick crop produces small ears, and a thin one large ears, and that the numbers of the former make up for the size of the latter. Thus a thick crop might have forty ears on a given extent of ground, which, at thirty grains to the ear, would yield as much produce as a thin crop of thirty ears, on the same extent of ground, with forty grains in each ear. But, as Mr Barnch Almack observed, if the ear alone were taken as the criterion of the crop, one of these crops would have ten bushels more of wheat upon it than the other, which would be an erroneous estimate, since both contained 1200 grains. The correct mode, therefore, he conceived, would be to count the average number of grains in the ear, and the number of ears in a given space. Mr Dyer had remarked that he sowed three bushels to the acre, consequently, in Mr Almack's opinion, two remarkable facts were proved. First, That as he generally finds as many bushels per acre as there are grains in an average ear, it follows that he usually has about as many wheat ears per acre as there are grains in a bushel of wheat. Second, That as he only obtains as many ears of wheat per acre as there are grains of wheat in a bushel, and as he sows three bushels on the acre, it follows that he sows three grains of wheat for each ear that he obtains. Hence it would seem that the rule would only hold good where the number of ears per acre are the same, or nearly so.

4575. In reference to the portion of the crop left in the soil after harvest, M. Boussingault observes, that "all the world acknowledges that the residue of the crops that enter into a rotation compensate, in greater or less degree, for what is carried away in the shape of harvest, and that in some cases they even add to the fertility of the soil, for in growing crops that leave a large quantity of residue, it is precisely as if a smaller quantity were taken from a given extent of surface."*

ON REAPING BEANS, AND PEASE, AND TARES WHEN GROWN FOR SEED.

4576. The leguminous crops, having either stiff or trailing stems, are reaped in a somewhat different manner from the cereal.

4577. Whenever the stems and pods of *beans* become black, the crop is ready to be reaped.

4578. Beans, whether sown in drills, (3979,) or in rows on the flat, (3980,) or

broadcast, (3981,) are only reaped with the sickle; and the instrument is used in the same manner in each case—that is, the stems are held steady by the left hand being pressed palmwards against them, and, almost coming under the arm, are cut with the point of the sickle by the right hand, the reaper stepping backwards as the work proceeds. Thus, as each stem requires to be cut separately, the reaping does not proceed very quickly when the crop happens to be strong.

4579. When the haulm is short and small, it is not unfrequently pulled up by the roots; but as the barn is thereby made very filthy with dust, pulling should never be practised.

4580. The scythe might be used in reaping beans, but the operation is so harsh to the arms that no reaper likes it; and, besides, the stems are difficult to be collected aright by the gatherer.

4581. When beans are sown by themselves, straw-ropes are laid down on the ground for bands: when pease are sown with them, their haulm makes excellent bands.

4582. The stems, cut as directed, are then laid evenly upon the band, whether of straw-rope or of pea-haulm; and the size of the sheaf very much depends on the length of the stems. Short stems will not bind together in a thick sheaf, nor will a thin sheaf of long stems stand well upright upon the ground.

4583. The bandster follows the reapers, and binds the sheaves in the manner he binds those of the cereal grains, and sets up the stooks in regular order in rows, composed of four or more sheaves, each pair set together on end. A bean-stook is never attempted to be hooded. It is of importance to keep bean sheaves always on end, as they then resist most rain; for if allowed to remain on their side, after being blown over by the wind, the least rain soaks them, and the succeeding drought causes the pods to burst and spill the beans upon the ground.

4584. Whenever the straw and pods of

* Boussingault's *Rural Economy*, p. 478—Law's translation.

pease become brown they are fit for reaping; and in seasons when the straw grows very luxuriant, it is cut down whilst it retains much of its greenness.

4585. None but the sickle can be used in reaping *pease*, as the trailing stems of the plant would inevitably entangle themselves around the head of the scythe. The reaper pulls straight the lying stems with the left hand, while the point of the sickle is used by the right to sever the plants from the ground—the reaper stepping backwards—most of the plants coming up by the root.

4586. *Pease* are not bound at first, but laid on the ground in separate bundles, where, after winning for some time according to the state of the weather, the bundles are rolled into an oblong form, and made firm by a wisp of its own straw acting as a binder round the middle. The bundles may be set together in pairs to form a sort of stook, or left singly over the surface of the field. *Pea* bundles are bound by women as well as men.

4587. *Tares* are most easily and quickly reaped by mowing with the scythe. They are separated in bundles after the mowers, by the gatherers, and placed asunder on the ground to win, and afterwards bound in a similar manner to the *pea*.

4588. Such is the diversity in the luxuriance of the crop of beans in different seasons, that the cost of reaping them varies from 4s. to 7s. an acre. *Pease* cost 3s. 6d. an acre. *Tares* cost 2s. 6d. an acre.

4589. In some seasons, such as dry and warm ones, *pease* and *tares* may be as early harvested as the cereal grains; but beans are always late, and sometimes not harvested until three weeks after all the other crops have been housed.

ON THE CARRYING AND STACKING OF WHEAT, BARLEY, OATS, BEANS, AND PEASE.

4590. It is necessary that reaped corn remain for some time in the stook in the

field, before it will keep in the large quantity composing a stack or in a barn. That time depends mostly on the state of the weather; for if the air is dry, sharp, and windy, the corn will be ready in the shortest time; while in close, misty, damp air it will require the longest time; and it depends partly on the state of ripeness or condition of the corn when reaped. On an average, one week for wheat, and two weeks for barley and oats, will suffice to win them. In this respect mowing manifests a decided superiority over reaping, inasmuch as mown wheat is ready for the stack in three to five days, and barley and oats in eight or ten—the chief cause of the difference being the loose and open state in which mowing places the straw, while the straw reaped by the sickle is much compressed in the lower part of the sheaf which most requires exposure. The celerity of winning is an important matter in effecting the safety of the crop, as may be observed from an instance adduced by Mr John Taylor in the harvest of 1841. “On the 28-9th of September, I had 30 acres of oats carted and stacked, which had been cut by the scythe the preceding week. On the evening of the 29th it began to rain, and continued very rainy for twelve days, during which harvesting was at a stand-still; and had the produce of those 30 acres been reaped by the sickle, it would unquestionably have been exposed to those twelve days’ rain, and thereby much deteriorated.”* I have myself observed many similar instances.

4591. Mere dryness to the feel does not constitute all the qualities requisite for making new cut corn keep in the stack. The natural sap of the plant must not only be evaporated from its outside, but also from its interior. The outside may feel quite dry, whilst the interior may be redolent of sap; and the knowledge of its condition constitutes the whole difficulty of judging whether or not corn will keep in the stack. One criterion exists by which it may be ascertained with certainty, in the straws being loose in the sheaf, and easily yielding to the pressure of the fingers, and in the entire sheaf feeling light when lifted off the ground, by the hand thrust into its middle.

* *Transactions of the Highland and Agricultural Society, July 1844, p. 261.*

beyond the band: for if the sheaf is dry and light in the heart, it must be so on the outside. In the winning, the sap of the straw of the cereal grains is no doubt converted into woody fibre, as that of the grasses is on being converted into hay, (4073.)

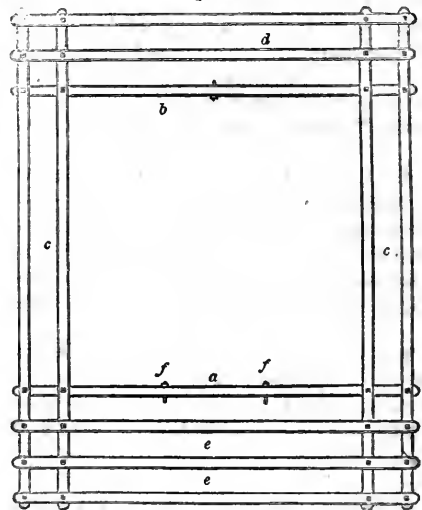
4592. The winning of corn is comparatively an easy matter when the weather is dry; but in windy and showery weather, the stooks are apt to be blown down and become wet, and incur the trouble of setting up again at the first recurrence of calm. When the air is calm, dull, damp, and warm, every species of grain is apt to sprout in the stook before it is ready for the stack. When much rain falls, accompanied with cold, the grain becomes sooner ready than the straw for the stack; and, to win the straw, the bands are not unfrequently obliged to be loosened, and the sheaf spread out to dry in the wind and sun; and, in like manner, the sheaf should be spread out in dry weather, when a large proportion of young grass is mixed amongst barley-straw. Corn wins in no way so quickly as in gaitins, fig 403.

4593. While the first reaped corn is winning in the field, the stackyard should be put in order to receive the new crop, by removing everything that ought not to be in it, such as old decayed straw, which should have been used in time for litter: weeds, which in many instances are allowed to grow, and shed their seeds, and accumulate to a shameful degree during summer, such as strong burdocks, thick common docks, tall nettles, and rank grass of every kind: and the larger classes of implements too are there accommodated, to be afterwards dispersed and exposed to the weather, for want of sheds to keep them in. Where stathels, fig. 132, are used they should be put in repair. Loose clean straw should be built in a small stack on one of the stathels, or other place, to be ready to make the bottomings of stacks as wanted. Drawn straw should be ready in a stack for thatching the stacks of barley as they are built, in case of wet weather occurring. Straw-ropes should be piled up in the hay-house, ready to be used in thatching. The tops or frames should be put on the tilt-carts; the corn carts should be put on their

wheels, and the axles greased; and the ropes should be attached to the carts. The forks fit for pitching the corn in the field, and from the carts to the stacks, should be ready for use in the field and in the stackyard. Negligence and want of foresight in all these particulars indicate improvident management in the farmer.

4594. The tops or frames for placing on the tilt-carts, fig. 175, are a light rectangular piece of frame-work represented in fig. 405, where *a*, *b* are the two main bearers, fitted to lie across the shellements of the cart. The foremost one *a* is slightly notched at *a* and *b*, fig. 406; and the hind one rests against the back-board of the cart, its top sides *e*, fig. 175, being first taken off. A pair of slight side-rails *c* and *c*, fig. 405, are ap-

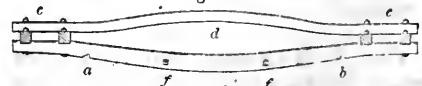
Fig. 405.



THE CORN AND HAY FRAME.

plied on each side, crossing the bearers, and notched upon and bolted to them with screw-bolts. These are again crossed by two rails *d* behind, and by three more *e*, *e* in front; and as these last project over the back of the horse, they are made in arch form as seen by *c d c*, fig. 406, to give

Fig. 406.



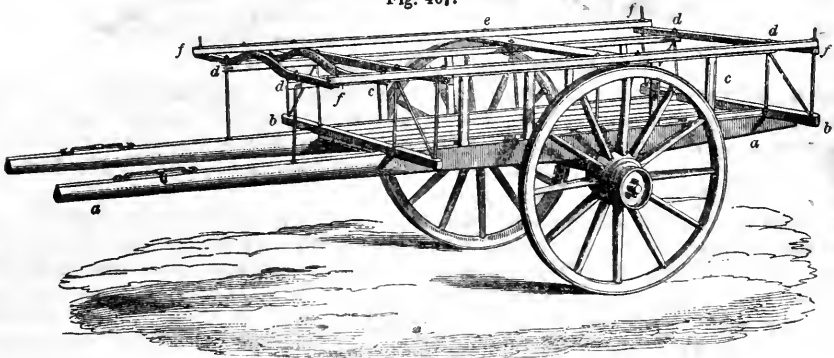
TRANSVERSE SECTION OF THE FRAME.

freedom to his motions. The extreme

length, from outside to outside of the front and back rails, is usually about $10\frac{1}{2}$ feet, and the breadth in the same manner is about $7\frac{1}{4}$ feet, affording a superficial area for the support of the sheaves of corn of 76 square feet. A simple and effective method of securing the frame to the cart is by means of the bolts, *ff*, figs. 405 and 406, in the bearers, the front ones passing through the head-rail of the front of the cart, and the hind one through the top-rail of the tail-board.

4595. But the common corn or hay cart is a more convenient and efficient vehicle for carrying the grain crops into the stack-yard than the tilt-cart with the frame, inasmuch as the load is more on a level with the horse draught, and, the body being dormant, the load is not liable to shake with the motion of the horse. Fig. 407 is a perspective view of such a cart. Lightness being an object in its construction, the shafts *a a* are usually made of Baltic fir, and are about 17 feet in length, of

Fig. 407.



THE CORN AND HAY CART.

which $6\frac{1}{2}$ feet go for the horse yoke and $10\frac{1}{2}$ feet for the body, measuring over the cross-heads *b b*. These are secured to the shafts by the iron standards passing through them and the shafts. Their sides are supported by oak standards *c c*; and these in their turn, along with the iron standards, support the inner top rails *d d*, *d d*, 12 feet in length, and the load-tree or rail *e*. The outer rails *ff f f*, also 12 feet long, are supported by iron standards resting on the extremities of the cross heads *b b*, and also by those of the broad load-rail *e*. The extreme breadth of the outer rails is 7 feet, and as the outer rails support the sheaves of corn over the wheels, and are 12 feet in length, it will be seen that the superficial area of the cart for the load is 84 square feet, which is greater than that of the top-frame of fig. 405. The two front cross-rails *f f* over the horse's rump are arched, to give him freedom of motion. The body is usually close-floored, besides having a low ledge-board running inside the standards *c c* to keep in the corn that may have shaken out of the sheaves. Corn carts are not furnished with wheels of their own,

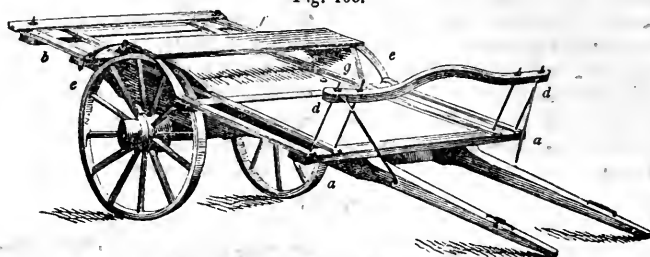
the body being set upon those belonging to the tilt-carts. The load-rail, 9 inches broad, is convenient to sit upon in driving, and to stand upon when forking the sheaves in unloading. This cart is easily converted into a dray-cart by simply removing the framework, which should then have the standards *c c* based upon two longitudinal rails, instead of being mortised into the shafts. In such a form it is eminently useful in carrying large timber. It weighs 8 cwt.

4596. A corn and hay cart, simple in construction, but possessing complete efficiency, and greater safety from upsetting than the former, was contrived by a farm-servant, Robert Robertson, and was introduced in 1832 in the west of Fifeshire, and of which fig. 408 is a view in perspective, with its wheels and axle in full working order. The shafts and body-frame of this cart may be considered as identical with the one just described, which, without the upper works, is the simple dray-cart. Upon this body-frame is placed the fore and back cross-heads *a a* and *b*, projecting beyond the body, their

extreme length being $7\frac{1}{2}$ feet. The other and lighter cross-rails are applied one before and another immediately behind the wheels, and the whole bolted to the shafts. Upon

these are laid a longitudinal rail on each side, and two similar portions of longitudinal rails are also laid on each side, extending from the fore and back cross-

Fig. 408.



ROBERTSON'S IMPROVED CORN AND HAY CART.

head to the wheel-rails; over these longitudinal rails is laid another light cross-rail behind, and the parts all secured with bolts. A light frame *d d* is raised upon the fore cross-head *a a* to a height of two feet, with two iron stanchion rods at each, and these surmounted by an arched rail, which is supported against the pressure of the load by two iron stays from the shafts. The outer longitudinal rails, being cut by the wheels as above described, are connected again by the arched iron bars *e* and *e*, which are bolted at the ends to their respective rails; and these are connected by the broad load-rail *f*, the arches rising sufficiently high to allow the wheels to have freedom to turn below the load-rail *f*. A side-board *g* is also raised on each side upon the body-frame, and under the load-rail, extending a little before and behind the wheels, thus preventing the sheaves from coming in contact with the wheels. The body-frame is floored over in the usual manner, and the space between the body and the inner longitudinal rails is filled up with narrow hinged flap-boards, which prevent the loss of the grain that may have been shaken out of the sheaves into the cart.

4597. Carts of this construction possess several advantages: from their simplicity is derived cheapness; and from the load assuming its full breadth over nearly the whole floor of the cart, at the lowest possible position, the centre of gravity of the whole load will be very considerably lower than in that of the formerly described cart, and still more so than on the top-frame. This last quality produces greater stability, and reduces the risk of upsetting, besides affording a greater facility of load-

ing. There is also the advantage of its easy conversion into an open dray-cart, for carrying timber or the like, by removing the upper framework. It weighs 7 cwt.

4598. The *forks* already described in (1420) are only fitted to be used among loose straw. Those used in the loading of corn require to have long shafts, not less than six feet, and small prongs. Such a length of shaft is required to lift the sheaf from the ground to the top of a loaded cart, or from the load-rail of the cart to the top of a stack. The fork used in the field should have a strong stiff shaft, as the load on the cart is at no great elevation. That for unloading the cart to the stack should be slender and elastic, as many of the sheaves have to be thrown a considerable height above the head. The prongs, being small, just retain hold of the sheaf, without being so deeply pierced into the band as to be withdrawn from it with difficulty. A deep and firm hold with long prongs renders the pitching of a sheaf a difficult matter; and if one of the prongs happens to be bent, or a little turned up at the point, the difficulty is much increased. The best fork for the person on the top of the stack to use, in assisting the builder, is the short stable-fork, of the form, but of shorter prongs than fig. 110.

4599. The loads of corn and hay on the carts are fastened with *ropes*, which should be made of the best hemp, soft and pliable. They cost $4\frac{1}{2}$ d. per lb. Ropes are either single or double, and both are required on the farm. Double cart-ropes are from 30 to 24 yards long and single ones half those lengths. The longest double rope weighs

rather more than 11 lbs., and costs 5s. The single ones are used on ordinary occasions, when a small load of straw or other bulky article is carted to short distances on the farm; but in harvest and hay time, double ropes are always used for security to the load. The double rope is made fast to the corn-cart by first doubling it, and then measuring its middle from the centre of the cross-head of the hind part of the body of the cart to its extremity on both sides, where a turn or two are taken round the iron standards and the cross-head by each division of the rope, the ends of which are then passed in the inside of the upper cross-heads, and brought over them to the outside. Each division is coiled up by holding the rope in the left hand at about two yards from the cart, and handing the remainder in coils with the right hand until the end of the rope is gained, when the coil is made to take a turn along the loose part of the rope in its middle, and then the loose part still remaining is slipped through one loop of the coil and passed over it so as to make a loop knot, which holds the coil suspended from the cart about three feet from the ground. Fig. 409 represents the rope

Fig. 409.



COILED UP CART-ROPE.

coiled and suspended, when not in use. When a ring is fastened in the cross-head of the cart, the middle of the rope is passed through the ring, and a turn taken round the extremity of the cross-head on each side of the cart, as above. Cart-ropes last according to the care bestowed on them. When used with the corn-cart they should never be allowed to touch the

ground, as earthy matter, of whatever kind, soon causes them to rot. When wetted by rain they should be spread out in the air to dry. On being loosened when the load of corn is to be delivered to the stacker, they should be coiled up before the load is disposed of, and not allowed to lie on the ground till the cart is unloaded. A soft rope holds more firmly, is more easily handled, and far less apt to cut than a hard one.

4600. *Straw-ropes* are made by means of the implement named the throw-crook. Various forms of this instrument is in use, and one of the most common is represented in fig. 410, which is made of a piece of

Fig. 410.



tough ash, about $3\frac{1}{2}$ feet long, the bent part of which is thinned off until it is capable of being bent to a curve, and is there retained by the iron stay *a*; the part *b* being left projecting beyond the stay, for the attachment of the first end of the rope that is to be made. The end *c* is furnished with ferule and swivel ring, by which it is either attached to the person by a cord passed round the waist, or held in the hand. In using this implement the rope-maker is stationary, usually sitting beside the

straw; and the spinner, with the throw-crook, moves backwards as the rope extends. In its action this form of throw-crook is attended with a jerking motion, when the left hand holds the swivel *c*, and the right one revolves the instrument round the shank. The direction of *cb* is in the line of the rope, and the twist given to the rope is effected by the revolution of the body of the implement around this line, generating which a pull is given to the rope at two opposite points in the circle of revolution, which may be greatly neutralised by the spinner causing both hands to revolve in small circles.

4601. Fig. 411 is a form of throw-crook in use in the western counties of Scotland. It is used by holding the wooden hollow cylinder *b* in the left hand. The end of

the rope is attached to the hook, and the iron spindle *a*, in continuation of the hook, is made to revolve by means of the handle *c*, which is attached to one end of the same crank *d* to which the spindle *a* is. In theory, the strain upon the instrument, while in action, should be along the spindle *a*, from the hook to the crank *d*; but in practice it acts in a line from the hook to the handle *c*, causing an uncomfortable strain upon the

Fig. 411.



ANOTHER FORM OF THROW-CROOK.

left hand, while the right one works the crank-handle with difficulty.

4602. I think the best form of throw-crook is represented in fig. 412, where the strain of the straw-rope is in a straight line from the hook *a*, along the spindle *e* to the handle *d*. The left hand holds the swivel-ring *c*, and the right hand causes the part *ebd* to revolve round the line *aed* by means of the handle *b*, which is covered with a loose hollow cylinder of wood, the rest of the instrument being made of iron.

Fig. 412.

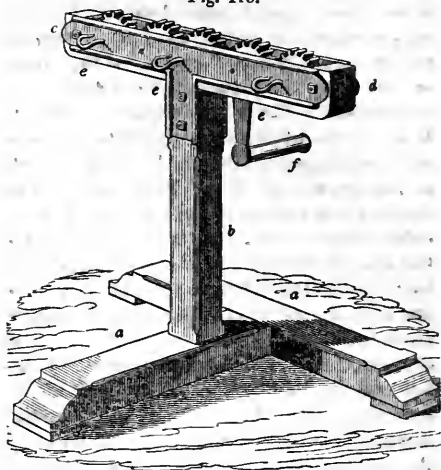


THE BEST FORM OF THROW-CROOK.

4603. The *straw-rope spinner* is an instrument of recent introduction to the farm, and is of considerable importance in facilitating the process of straw rope-making on large farms. Comparing it with the old and primitive instrument, the throw-crook, fig. 410, the advantage is considerable, inasmuch as two persons are engaged in the making of one rope with the throw-crook; whereas, with the spinner, four persons are only required to make three ropes, thus effecting a saving of one-third of the time occupied by the old practice. Fig. 413 is a view of this machine, consisting of a sole frame *aa*, with an upright post *b* tenoned into the sole, and carrying the cross-head *cd*. The

cross-head is a hollow box or case adapted

Fig. 413.



THE STRAW-ROPE SPINNER.

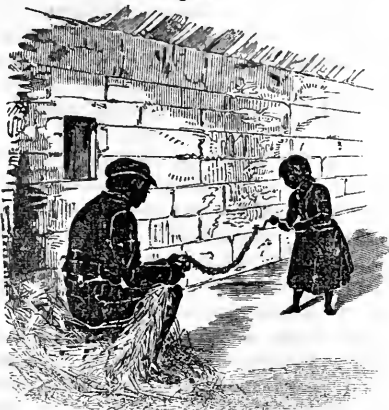
to contain the machinery, consisting of five light spur-wheels, about six inches diameter, placed as seen in the case *cd*. Of these, the central and the two extreme wheels are mounted upon axles, which terminate in the hooks *eee*; the other two wheels being merely placed intermediate, to produce revolution in the three principals in one direction. A winch-handle *f* is fixed upon the axle of the central wheel, on the side opposite to the hooks; and to prevent the machine from moving with the strain of the ropes, a few stones, or other weighty substances, are laid upon the sole-frame. The machine is then put in operation by the driver turning the handle, and the three ropemakers, each with a quantity of straw under his arm, commences his rope by binding a few straws round the hook appropriated to himself. He then proceeds backward, letting out the straw as he advances; and the rope takes the twist, until the length required is completed, when each man coils up his rope into an oval ball. The price of a spinner is from £2, 5s. to £2, 10s.

4604. Another form of this machine is that which is strapped to the body of the driver, he moving away from the stationary ropemakers. This method is attended with inconvenience, especially to the driver, who, having the machine strapped in front of his body, the handle being at the end, and the machinery consisting of

bevel gear, having the external form of the cross-head alone of fig. 413, the handle is brought so near to his body that much of the muscular force of the arm is lost by its misapplication.

4605. Straw is twisted into ropes in this manner: The left hand of the twister, a field-worker holds by the swivel ring at the end of the shank of figs. 410 and 412, and by the cylinder *b* of fig. 411. Her right hand grasps the middle of the shank of fig. 410, and of the handle *c* of fig. 411, and of *b* fig. 412. On the spinner, a man, placing a little drawn straw in the hook, the twister causes the hook to revolve round an axis, as described in (4600), and walks backward, along a path swept clean, in a shed or the stable. The spinner sits on a stool, or on bundles of straw, and nearly closing the left hand, lets out the straw gradually between the thumb and the fingers, retaining it till sufficiently twisted, while the right hand is engaged supplying small portions of straw in equal and sufficient quantities to make the rope uniform in thickness throughout, the twister drawing away the rope as fast as the spinner lets it out. Where the rope is let out unequally, it breaks at the small part; when twisted too much, it snaps asunder; when not twisted enough, it comes asunder at any place by the least pull; and when the twister does not keep the rope straight as fast as it is let out, it twists into loops, which are not easily made straight again.

Fig. 414.



THE PROCESS OF MAKING A STRAW-ROPE.

All loose straws and other material should be swept away from the walk in which

straw ropes are made, otherwise they will be picked and appropriated by the twisting-rope. After the rope has been let out to the desired length, the spinner winds it firmly in oblique strands on his left hand and arm into an oval ball, the twister advancing towards him as fast as the spinner coils the rope, which is finished, and made firm by passing the end of it below one of the strands. In the Borders the spinner works the straw into form with both hands, while stooping with his head down and his back turned to the twister; but the rope thus made is always thick and rough, compared to the mode described above. If thistles have been negligently left in the straw, the spinner will be sure to suffer severely by their stings. Fig. 414 represents the process of making a straw-rope, as just described.

4606. The best sort of straw for rope is that of the common or Angus oat, which being soft and pliable, makes a firm, smooth, small tough rope.

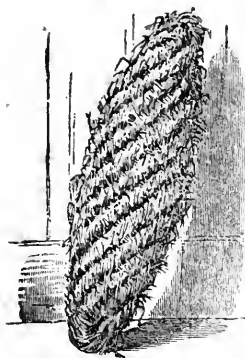
4607. The ordinary length of a straw-rope for a large stack may be taken at thirty feet. Counting every interruption, a straw-rope of this length may take five minutes in the making—that is, a hundred and twenty ropes in ten hours. A man's wages, 20d., and a woman's, 10d., making together 2s. 6d., will make the cost of making a single rope just one farthing. As three spinners let out to one twister, and as a machine spins as fast as a throw-crook, the cost of making each rope with the machine, fig. 413, will be as much less than one farthing as the saving of the wages of two twisters.

4608. In using the throw-crook the spinner sits, while with the spinning-machine he walks backward, and in coiling up the rope walks forward again to the machine, where he is ready to begin to spin again. Inconveniences attend the use of the machine, fig. 413: when one of the spinners breaks his rope, he is thrown out of work till the others begin a new one; and all the spinners must let out with the same velocity, otherwise a longer and softer, and a harder twisted and shorter rope will be made at the same time.

4609. Fig. 415 represents a straw-rope

coiled up in the neatest and most convenient form. When the ends are made smaller than the middle, the rope can be easily taken hold of, and carried, and when the form is oval rather than spherical, the coil can be the more easily thrown upwards to a greater height, such as to the top of a stack.

Fig. 415.



A STRAW-ROPE COILED UP.

4610. Among the other things required to be in a state of readiness before the crop is led into the stackyard, is straw drawn in parallel reeds and bound up in bunches. Straw is *drawn* and *bunched* in this manner:—The straw was mowed in the straw-barn, (1763;) and in commencing to draw it, the man takes a wisp from the mow, and places it across his body, and after making the straws straight first with one hand and then another, he takes hold of each end of the wisp, and on spreading out his arms separates the wisp into two portions. Bringing both hands together, he lays hold of the severed wisp with the left hand, and on taking hold of its other end with the right draws the straws asunder, as before. Bringing again both hands together, he goes through the same process, and as often until he sees that the straws are parallel and straight, when he lays down the now drawn wisp carefully upon the floor of the barn.

4611. The state of the straw, and the kind, render the drawing more or less easy and expeditious. When it has been much broken in the thrashing, it requires the more drawing to make it straight; and of all the kinds of straw that of wheat, being long and strong, is the most easily and quickly drawn, (1964,) barley straw being the shortest and the most difficult to draw, (1968.) Oat straw is the most pleasant of any to draw, (1972.)

4612. After as much has been drawn and laid down as to make a bunch of

about fifteen inches in diameter, the man makes a *thumb-rope*, by twisting a little of undrawn straw round the thumb of his right hand, drawing it out with his left and twisting it with his right alternately, until a short rope is made, one end of which he places on the floor and puts his foot upon by the side of the drawn straw; and, keeping hold of the other end in his left hand, puts the drawn straw into the rope with his right; and then, holding both ends

Fig. 416.



A BUNCH OF DRAWN STRAW.

of the rope, binds the straw into a bunch as firmly, and in the same manner, as a bandster does a sheaf of corn, (4479.) Fig. 416 represents a bunch of drawn straw.

4613. The carts, forks, straw, and ropes, being in readiness at the steading, and the corn fit for carrying to the stackyard, the first thing is to provide an efficient person to fork the corn in the field to the carts; and a man is the best for this work, as he is able not only to wield the sheaves with ease, but possesses dexterity to place them in the positions most convenient for the carter to build them on the cart. Throwing the sheaves in an indiscriminate manner, or too quickly upon the cart, makes the work no easier for the forker; while the carter has the additional trouble of turning the sheaves to arrange them as a load, when his footing upon the cart is at best insecure. A loss of two or three minutes incurred in any way, in loading each cart, makes a considerable loss upon the day's work.

4614. In carrying the crop off the ground, the object is to do as little injury as possible to the land with the cart-wheels, particularly to the young grass; for which reason, as well as for forming an unerring guide, the horses should walk in the open-furrow between the ridges, while the wheels pass along their furrow-brows, (738.) When corn is cut with bandwin reapers, the stocks of two ridges being placed on one, the cart clears the produce of two ridges; and the same may be the case with the mown corn, provided the bandsters are instructed to

set the stooks in the same position upon the ridges. When the stooks are set on the furrow-brows of the ridges, on each side of the centre open-furrow of the four ridges occupied by two band-wins, as suggested in (4481,) the carts would at once clear the stooks of four ridges. In thraving, the stooks being set on every ridge, the forker is obliged to go from one ridge to another to clear two ridges, thereby occasioning much loss of time.

4615. In forking a hooded stook from the ground, the hood sheaves are first taken, and then the sheaves from the body of the stook as they were placed in setting the stook—that is, the sheaves at the ends are taken before those in the middle, and one pair is taken away before a sheaf in the next pair is touched. More loss of time is involved in disregarding this order of removal of the sheaves than might appear without consideration, for if the centre sheaves are taken away before the end ones, not only more force is required to do it, but the end ones will likely fall down in the exertion to extricate the central ones; and if one side of a stook is taken away before the other, the remaining side will fall down. In either case the sheaves will be reached by the fork with inconvenience. When stooks have stood long upon the ground, they require more force to remove them from the ground than those which have stood for a shorter time.

4616. On forking gaitins from the field, they must first be bound into sheaves, which is done by loosening the slack band from its tying, and slipping it down the body of the gaitin to the proper place, and then binding it in the manner of a sheaf when reaped. A number of hands are required to bind gaitins as fast as they are carted off, and they are not stooked when bound, nor left scattered on the ridges as they stood before, but are laid in heaps, with the corn ends away from the cart, on alternate ridges, as near the furrow brow as to be most conveniently placed for the forker.

4617. A corn-cart is loaded with sheaves in this way:—The body is first filled with sheaves lying with their but-ends towards the shaft-horse's rump at one end, and the back-end of the cart at the other. When these sheaves come to the level of the frame

or shelve-ments of the cart, other sheaves are laid across them in a row along both sides of the frame, with their but-ends projecting as far beyond the outer rail of the frame as the band, the particular sheaf on each *corner of the frame* being held in its place by transfixion upon a spike of the elongated bolt which secures the corner of the outer-rail frame, fig. 407 *f*. Another row of sheaves is then placed upon these last, and their corner ones are kept in their places by a wisp from each sheaf being laid under and held fast by the weight of the adjoining sheaf. Sheaves are then placed along the middle of the cart with their but-ends to both its ends, to hold in those below them, and to fill up the hollow of the load. Thus row after row of sheaves is placed, and the hollow in the middle filled up, till as much is built on as the horses can conveniently draw, 12 full stooks being a good load. Before finishing, it should be ascertained that the load is neither too light nor too heavy upon the horse's back; and if the cart has been evenly laden according to its form, there is no risk of either inconvenience being felt by the shaft-horse. A load thus built will have the but-ends of all the sheaves on the outside, and the corn ends in the inside, as may be seen at *f e g* in fig. 417.

4618. The ropes keep the load from jolting off the cart upon the road, and in crossing gaw-cuts on the head-ridge of the fields. They are thrown across the load diagonally to the opposite shafts at the front of the cart, and an end is made fast to each shaft, the forker on the ground holding on the slack, while the ploughman on the load gives efficacy to the rope, by pulling it tight from behind, and trampling on the sheaves to make them the more firm. The crossing of the ropes at the centre prevents the load splitting asunder over the sides of the cart, while shaken along the road. Some ploughmen profess to show their dexterity in building loads of corn, by bringing them to the stack-yard without the assistance of ropes; but there is no use of running the risk of losing time by breaking the load and strewing the road with sheaves. Such a fate, even with the assistance of ropes, attended the first load I tried to build. When the corn is mown, a woman should be em-

ployed to rake the ground on which the stooks stood, as they were set before the ground was raked at the time of mowing.

4619. When corn is fit for stacking, the carrying is continued from break of day to twilight, provided there be no heavy dew at morning or evening. From a little after sunrise to a little after sunset, the corn may be taken in with great safety. It is customary, in some parts of the country, to keep the horses in the yoke all the time employed at leading during the day, and to feed them with corn in nose-bags while the carter is dining, and also to give them green food, such as tares, while the cart is unloading at the stack. In other parts, the horses are taken out of the yoke, watered, and put into the stable, where they receive their corn while the men are at dinner. This is the easiest plan for the horses, in which they will work the longest day's work with less fatigue, though it usually occupies an hour of the best part of the day before they are again on the road, whereas half an hour, spent in the other case, is sufficient for the men to dine, and the horses to feed on corn. Some horses are apt to take fright, when the bridles are temporarily slipped off their head for the purpose of taking the bit out of their mouth, to allow them to eat the tares with freedom. Such an occurrence is doubtless the result of bad breaking in. To avoid it, in the case of a horse known to be easily frightened, the bit should be fastened with a small strap and buckle to the near side of the bridle.

4620. A load of tares is brought to the steading fresh in the morning, for the horses employed at leading. Tares are not fit for horses until the pods are pretty well filled with grain, as prior to that state they are apt to purge and weaken them, when working much in the cart, which they are obliged to do when carrying in the corn.

4621. While the first cart is going to and loading in the field, and returning to the stackyard, the builder of the stacks collects his forks and ladders, (1743,) and trimmer, fig. 418; and his assistant, a field-worker, who pitches the sheaves conveniently for him on the stack, fetches a few straw-ropes, fig. 415, and a hand rake, fig. 345, into the stackyard. The

first stacks are built on the stathels, fig. 132, arranged on the outer margin of the stackyard along the fence, and require no peculiar preparation for the reception of the stacks. The steward should build the stacks unless he be specially engaged with the reapers in the field, when another man should be hired to do it; but on a large farm more than one stacker will probably be required at all times. When more than one is employed, each should have a head of carts leading to him, in conformity to the distance the corn has to be brought; and when both heads are leading from the same field, both should have the same number of carts. The same carts and forker should serve the same builder, that the corn may be brought to each in a regular routine.

4622. In filling a stackyard, the barley being first thrashed their stacks should be placed nearest the barn; and wheat being the last thrashed, their stacks are placed on the stathels round the outside of the stackyard. Oats being required at all seasons, their stacks may be placed anywhere. The stacks of pease and beans either fill up the heart of the stackyard at last, or are placed in a convenient place on the outside.

4623. In setting a loaded cart to the stool or stathel of a stack, it should be studied to let the ploughman have the advantage of any wind going in forking the sheaves from the cart. The stack should be built in this way:—Set up a couple of sheaves against each other in the centre of the stathel, and another couple against their sides. Pile other sheaves against these in rows round the centre, with a slop downwards towards the circumference of the stathel, each row being placed half the length of the sheaf beyond the inner one, till the circumference is completed, when it should be examined; and where any sheaf presses too hard upon another, it should be relieved, and where a slackness is found, a sheaf should be introduced. Keeping the circumference of the stack on the left hand, the stacker lays the sheaves upon the outside row round the stack, placing each sheaf with his hands upon the hollow or intermediate space between two of the sheaves laid in the preceding row, close to the last one, and pressing

it with both his knees, as represented at *h*, fig. 417. When the outside row is thus laid,

Fig. 417.



THE BUILDING OF A STACK OF CORN.

an inside one is made with sheaves whose but-ends rest on the bands of the outside row as seen at *i*, thereby securing the outside sheaves in their places, and at the same time filling up the body of the stack firmly with sheaves. A few more sheaves may be required as an inmost row, to make the heart of the stack its highest part. It is of immense benefit to a stack to have its centre well filled with sheaves, as it is the heart sheaves which retain the outside ones in their places in the circle, with an inclination downwards from the centre to the circumference; and it is this inclined position of the outside sheaves that prevents the rain finding a passage along the straw into the very heart of the stack, where it would easily find its way, were the sheaves inclined downwards to the centre of the stack, and where it would soon spoil the corn. The sheaves that are so spoiled are said to have taken in *pen-wet*.

row, along the bands of the outside one, with a few sheaves crossing one another in the centre, make such a stack completely hearted. Where long wheat is raised, as in the Carse of Gowrie, which often reaches from 5 to 6 feet in length, the stack should be at least 18 feet in diameter, to give room to a few sheaves for the hearting.

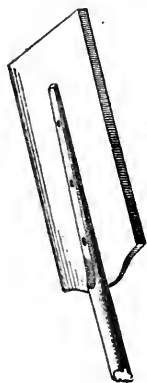
4625. A stack of 15 feet in breadth is rather too much for the carter to fork heavy sheaves across to the stacker, when the stack has attained the height of his head, and when the load in the cart becomes as low as the load-rail. The stacker should always receive the sheaves within easy reach, as he cannot rise from his knees to take them without much loss of time, and without the risk of making bad work. To expedite the building, a field-worker *k* should stand on the stack, to receive the sheaves on a short fork from the carter, and to throw them to the stacker in the position they are wanted by him, as the sheaf *l* is shown, in order to save him the trouble of turning them. By a little management, the field-worker might receive every sheaf as the carter pitches it from his fork upon her fork; and, to prevent it falling from the fork, she should catch the coming sheaf at the band with her fork, at which point the sheaf is balanced, and most easily wielded, being its centre of gravity, and throw it in its proper position a little before and at the right hand of the stacker, with the but-end always pointing to the circumference of the stalk. That the work may go on in the most regular order, the carter should pitch the sheaves from the cart just as fast as the builder can use them, and no faster, having only one sheaf in reserve on the stack in advance of the builder—for any more is of no use to him, and he must leave them behind him. It will also be easier work for the field-worker, as well as for the better laying of the sheaves to the builder, that she is able to use the fork equally well with the right and the left hand, as otherwise she will be obliged to swing and throw the sheaves across herself for half the round of the building of the stack. The field-worker remains on the stack as long as she has a footing to hand the sheaves to the builder.

4624. The number of rows of sheaves required to fill the body of a stack, depends on the length of the straw and the diameter of the stack. For crops of ordinary length of straw, such as from $4\frac{1}{2}$ to 5 feet, a stack of 15 feet diameter is well adapted; and in which one inside

4626. As each cart is unloaded, the

stacker descends to the ground, by means of a ladder, such as fig. 143, and trims the stack, by pushing in with a fork the end of any sheaf that projects further than the rest, and by pulling out any that may have been placed too far in. As the stack rises in height with cart-load after cart-load, the trimming cannot be conveniently done with a fork; a half-inch thick flat board about 20 inches in length, and 10 inches broad, nailed firmly to a long shaft, fig. 418, is

Fig. 418.



A STACK TRIMMER.

an appropriate instrument for beating in the projecting ends of the sheaves, and giving the body of the stack a uniform roundness. It seems to be considered by builders necessary to make the stack swell out as it proceeds in height, if we may judge from common practice; but no such expedience is necessary for throwing off the drops of rain from the eave, as the eave itself, on the stack subsiding after being built a few days, projects sufficiently out to throw off the drops. The leg of the stack should, therefore, be carried up perpendicularly. As a stack of 15 feet in diameter should ultimately stand 12 feet high in the leg to maintain a due proportion, an allowance of about one foot for subsidence, after the top is finished, is generally made. The height is measured with the ladder, and allowing 2 feet for the height of the stathel, a 15-foot ladder will just give the desired measure of the height of the leg before the top is built up. Fig. 420 represents a stack built upon a stathel.

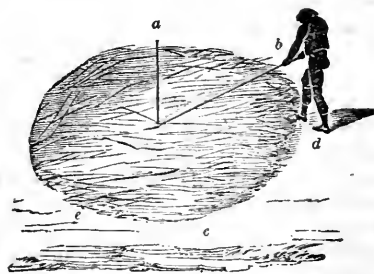
4627. The eave of the stack is formed according to the mode in which it is to be thatched. If the ropes are to be placed lozenge-shaped, the eave row of sheaves is placed just within the topmost row of the leg. If the thatching ropes are to run from the crown of the stack to the eave, the eave sheaves are made to project 2 or 3 inches beyond the topmost row of sheaves.

4628. In building the top of a stack, every successive row of sheaves is taken as much farther in as to give the slope

the same angle as a common roof, one foot below the square, as explained in building the top of a hay-stack, (4045.) The bevelled bottoms of the sheaves, acquired by standing in the stook, answer the slope of the top pretty nearly. The hearting of the top of a stack should be attended to particularly, as on rain obtaining admission from the top of a stack it cannot be prevented descending through its entire heart. After the area of the top has contracted to a space on which 4 sheaves only can stand upright, they are so placed erect, with their butt-ends spread a little out, and their tops gathered in so as to complete the figure of the cone. These top sheaves are held in their position against the effects of wind, by means of a straw rope wound round them, the ends of which are fastened to the stack.

4629. When stacks are built on the ground, stools of loose straw are made for them to stand upon, to preserve the sheaves at the bottom receiving injury from the dampness of the ground. A stool for a stack is formed in this manner:—Stick a fork in the ground, on the spot where the centre of the stack is desired to stand, as *a*, fig. 419. Put a quantity of dry straw round

Fig. 419.



MAKING THE STOOL FOR A CORN-STACK.

the fork, and shake it up with a fork as the litter of a horse in a stable is shaken, and then spread it out in equal thickness over the area the stack shall occupy. Then taking a long fork *b*, with the radius of the stack notched upon its shaft, embrace the shaft of the upright fork *a* between its prongs; and push in and pull out with the foot the straw, so as in walking round the circumference of the stool to give it the form of a circle, *e*, *c*, *d*, *b*, having a diameter equal to twice the radius notched upon the shaft of the fork.

4630. Sheaves cut with the sickle having a more uniform stubble end than when mown with the scythe, are more easily built into a stack, and give it a more handsome appearance; but being close, exclude the external air, and cannot be so soon stacked. A stack of mown sheaves is rough but open, and can be put up in safety in a state of dampness which would be disastrous to shorn sheaves. When sheaves are mown by inexperienced hands, a considerable quantity of grain is exposed on the outside of the stack, owing to the straws having been irregularly laid in the swath and into the sheaves; but with dexterous mowers the quantity thus exposed is very trifling, and will only happen when the wind has blown in a direction contrary to that in which the crop has been partially laid, and yet not sufficiently strong to turn it completely back.

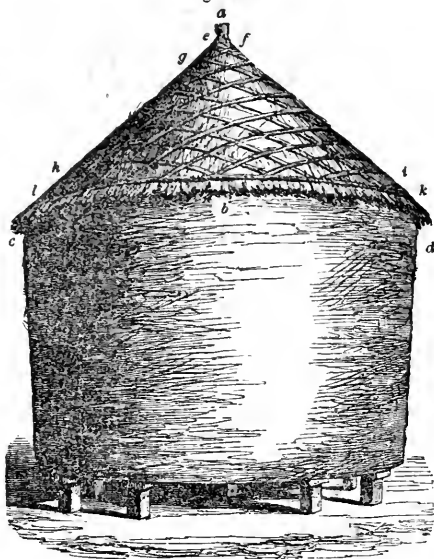
4631. A rough stack of mown sheaves may easily be made smooth, and free from projecting ears of grain, which need not be lost. A man can dress a stack in an hour with a scythe-blade fixed to a fork-shaft, causing the shorn heads to fall on a barn-sheet spread on the ground to receive them. A field-worker should assist in shifting the sheet round the stack, emptying it, and carrying it from stack to stack. Such a shaved stack is represented by *c*, fig. 143.

4632. Seldom is leisure found to thatch stacks as long as there is corn to carry in, and the finer the weather the less leisure presents itself. A damp day, however, which prevents leading, answers very well for thatching, as the thatch straw is not the worse of being a little damp; but in heavy rain it would be improper to thatch and cover up so many wet ends of sheaves as the top of a stack contains.

4633. The materials should all be at hand before commencing the thatching of stacks—drawn bunches of straw; coils of straw-ropes, ladders, forks, hand-rakes, and graips. To get on with the business quickly, a man and two assistants are required for each stack—the most convenient and thrifty assistants being field-workers, who fetch straw and ropes when wanted, supply the thatcher with straw, and tie the ends of the ropes.

4634. The thatching of a stack is done in this manner — I shall first describe the lozenge-shaped thatching, as being the most common: On the thatcher ascending to the top of the stack by means of a ladder, which is immediately after taken away by an assistant, a bunch or two of drawn straw, fig. 416, are forked up to him by one of his assistants, a field-worker, which he keeps beside him behind a graip, stuck into the top of the stack, as noticed in covering the hay-stack, (4049.) The straw is first laid upon the eave, beyond which it projects a few inches, and then in an overlapping manner upwards to the top. Where a but-end of a sheaf projects, it should be beaten in, and where a hollow occurs, a but-end of a sheaf should be drawn out, or filled up with a little additional straw. In this manner the straw is evenly laid all round the top of the stack, to the spot where the thatcher began. Supposing he has thus put the covering on the top of the stack, fig. 420,

Fig. 420.



THE LOZENGE MODE OF ROPING THE COVERING OF A CORN-STACK.

all round to the line from *a* to *b*, before closing up which he makes the top *a*, consisting of a small bundle of well-drawn long straw, tied firmly at one end with a piece of cord; the tied end is cut square with a knife, as shown at *a*; and the loose end is spread upon the covering, and forms

the finishing to it. To secure this top in its place, a straw-rope is thrown down by the thatcher from *a* to *d*, the end of which his assistant on the ground fastens to the side of the stack, as far up as she can conveniently tie it. After passing the other end of the same rope round the top, he throws it down in the same direction, where it is also fastened to the stack. In like manner he throws down both the ends of a rope from *a* to *c*, and they are also fastened by the assistant. The returning parts of these two ropes are seen at *e* and *f*. Having thus secured the top, the thatcher closes in the covering from *a* to *b*, where the ladder is placed to let him down. Taking a longer ladder to *c*, he inclines its upper part nearly parallel to the covering of the stack, and secures its lower end from slipping outwards by a graip thrust against it into the ground. He then mounts and stands upon the ladder at a requisite height above the eave *c*, where he receives a number of coils of ropes, fig. 415, from his assistant, which he keeps before him between the steps of the ladder. To give the thatch-straw smoothness, it should be stroked down with a long supple rod of willow, before the ropes are successively put on. Holding on by the loosened end of a coil of rope, he throws the coil from where he stands on the ladder above *c* down towards the direction of *d* to the right of the top *a*, to his assistant, who, taking it in the hand, allows the thatcher to coil it up again upon his hand, without ruffling the covering of the stack, till as much of it is left as to allow her to fasten it to the side of the stack, while the thatcher adjusts its position parallel to the rope he formerly placed round the top *a*, and the round of which is seen at *e*. The thatcher then throws the newly coiled end in the same direction of *d*, to the left of the top *a*, where, on his assistant taking hold of its end, he retains the rope in his hands by the double, and adjusts it in its position parallel with the former rope round *a*, and keeps it there till the assistant pulls it tightly down, and makes it fast to the stack like the other end. The return of this last rope is seen at *g*. The reason that the thatcher is obliged to throw down the rope at first *coiled*, and to coil up again the second end before it is thrown down, is, because, were the ends of the

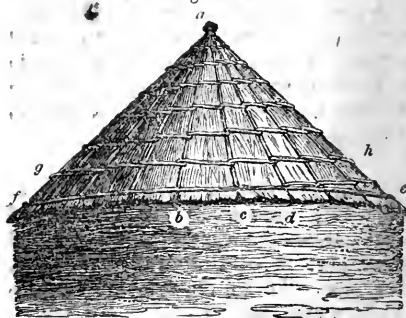
straw-ropes not in a coiled state, they could not be thrown down by the thatcher within reach of the assistant. Thus the thatcher puts on every rope parallel to each other below *g*, till the last one on that side has reached *h*. To give the ropes a closer seat, they should each receive a tap here and there with a fork, from the thatcher, whilst the assistant is pulling the last end tight. He then takes the ladder to *d*, and placing and fastening it there, as he did at *c*, he puts on every rope parallel to each other below *f*, till they reach the last one, *i*. Ropes thus placed parallel from opposite sides of the top of a stack cross each other in the diamond or lozenge-shape represented in fig. 420. On a stack 15 feet diameter at the base, 16 feet diameter at the eave, 12 feet high in the leg, and $6\frac{1}{2}$ feet high in the top, 10 ropes on each side are quite sufficient to secure the thatch.

4635. The ends of the ropes are fastened to the stack by pulling a small handful of straw from a sheaf a little out of the stack, and winding part of the rope round it; and the ball thus formed is pushed through between the rope and the stack, which keeps the rope as tight as would a knot.

4636. Windy gusty weather is very unfavourable for the thatching of stacks, the thatching being ruffled up by every gust.

4637. Another method of roping the thatching of a stack is shown in fig. 421.

Fig. 421.



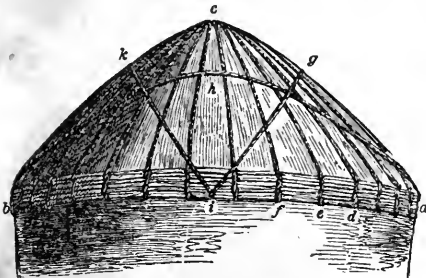
THE NET-MESH MODE OF ROPING THE COVERING OF A CORN-STACK.

The straw is put on in precisely the same manner as described for fig. 420. The ropes are then all crossed over the crown

of the stack, and are so arranged as to subdivide the top into equal similar triangles, as *b a c*, *c a d*, and their ends are fastened into the side of the stack. The ropes, at their crossing over the top, are fastened together by a rope, which is tied above them, and cut off in the form of a rosette, as at *a*. The ropes which cross these are either put on spirally from the top *a*, till they terminate at *d*, as represented in the figure, and to which form it is well adapted, as every turn round the perpendicular rope brings the horizontal one to a lower level; or separate ropes are put on in bands, parallel to the eave, and twisted round each crown-rope, at equal intervals of space, from the top *a* to the eave-rope *e f*. This mode of roping requires fully more ropes than the last method, though the crown-rope may be fewer in number than shown by *a b*, *a c*, and *a d*; but it perfectly secures the thatch against any force of wind, and is therefore well adapted for exposed situations. It is not unfrequently to be seen in the Highlands of Scotland, and in other northern counties.

4638. Another mode of roping the covering of a stack is applicable to all stacks whose eave is formed of a row of sheaves projecting beyond their bodies. It is shown in fig. 422, and was once in

Fig. 422.



THE BORDER METHOD OF COVERING AND ROPING A CORN-STACK.

common use in Berwickshire, but now seems confined to Northumberland. The first thing done, is to put a strong eave-rope round the stack, below the projecting row of sheaves from *a* to *b*. The straw is then put on in a similar manner to that last described, but rather thicker, and it is made to project farther down than the line of the eave-rope. The tops of the finishing sheaves of the stack are pressed down, and a somewhat large hard bundle

of short straw is placed upon them, to serve as a cushion for the ropes to rest upon, and which is put into its place after most of the covering has been laid on. The thatcher then perches himself upon the top of this hard bundle, where he receives the ropes as they are wanted, on the prongs of a long fork, on being thrown up to him. Some dexterity is required to throw a coil of straw-rope fig. 415, to the top of a stack. The best position to do it is to stand as far from the stack as to see the thatcher entirely clear of its head; and then, taking a coil by the small end, pitch it upwards with a full swing of the arm, parallel to the covering of the stack, towards the thatcher's feet, and he will catch it firmly on the prongs of the fork; if aimed at a higher level or to either side, the fork will be almost certain of missing it, the critical position of the thatcher not allowing him the freedom of his body, and only his arms. He thus receives a number of coils, and places them at his feet. Uncoiling the half of a rope, by coiling it on his right hand, the thatcher throws the hand-coil over the eave to his assistant, who holds on by that end while he throws the other coiled half down in exactly the opposite direction, across the top of the stack, to the other assistant, who lays hold of its end: then both assistants pull the ends of the rope, the thatcher tapping it firmly with the fork, and the ends are fastened to the opposite sides of the stack. One assistant may suffice, by tying first one end of the rope, and then the other; but with two assistants the roping is not only conducted with greater celerity, but much more firmly. This rope after rope is thrown, at equal intervals of space, to the number of 30, from *c* to *d*, *e*, *f*, before the top of the stack is sufficiently roped. The ropes, where they cross at the top, are tied together with a piece of straw-rope, to prevent their slipping off. A ladder is placed upon the thatching, down which the thatcher then descends to the ground.

4639. Another method of thatching stacks, most common in England, is the insertion of handfuls of well-drawn wheat straw into the bents of the sheaves on the top of the stack, and which are kept down with stobs of willows, or sewed on with tarred twine, being in imitation or

the thatching of cottages. In this method no straw ropes are used; and, finished by a dexterous thatcher, it gives the stacks a remarkably neat and permanent appearance. I am not sure that this method would resist the force of much windy weather, though its smooth surface would detain the snow upon the tops of the stack a much less time than any of the ropings described above.

4640. It is seldom that the thatching of a stack is finished when the straw and ropes are first put on; the object of thatching being first to place, in the shortest time, as many stacks as possible beyond danger from rain; so that most of them are covered to a safe state, and the finishing is left till more leisure is found, and until the stacks subside to their fullest degree. Stacks to be early thrashed, such as those of barley, seldom receive finishing at all; and many farmers only finish the outside rows of stacks, and some particularly so only if conspicuously seen from a public road. It is a mark of slovenly management to leave stacks unfinished in the thatching, and in windy weather unfinished stacks are liable to be stripped of their thatching altogether. It is excusable to leave a few of the stacks to be earliest thrashed unfinished in the thatching; and for the same reason they may safely be built on stools instead of stathels. But finishing should be the rule, and it is inexcusable to neglect it when both weather and time permit it to be done.

4641. The finishing of the thatching in fig. 420 is done in this manner:—A rope is spun long and strong enough to go round the stack at the eave, from *k* to *l*. Wherever two ropes from opposite directions cross the eave-rope, they are passed round it, and, on being cut short with a knife, are fastened to the stack in the manner described in (4635.) After all the ends of the 20 ropes are thus fastened to the stack, the projecting part of the thatch at the eave is cut with a knife all round the stack, to the effect shown along *d*, *b*, *c*. Of all the modes of thatching, I see none more efficient and better looking than the lozenge shaped.

4642. The mode of finishing the thatching of fig. 421 is this:—An eave-rope,

e f, is first put round the stack. The crown-ropes *a b*, *a c*, *a d*, are passed at each end round the eave-rope *e f*, and are fastened to the stack immediately under the straw projecting from the eave in the manner described in (4635.) The projecting straw at the eave is cut short with a knife, in the fashion shown from *b* to *d*.

4643. The difficult part of roping, in fig. 422 is in finishing the eave, which, if well done, looks remarkably neat; but, if otherwise, has a very slovenly appearance. The eave is finished in this way:—The eave-rope having been already put up, the ends of the ropes are loosened from the stack, and passed from below between the eave-rope and the stack, and, on being brought upwards, are passed behind the ropes themselves, about 8 or 9 inches above the eave-rope. The end of the first rope, suppose *c d*, being thus fastened, the part of the thatch straw which projects beyond the eave is brought horizontally along its face; and the second rope *c e*, on being loosened from the stack, is placed over the horizontal straw, before being passed below the eave-rope, and then brought upwards and passed behind itself, as the first rope was. The end of the first rope, and that of the second, as also the projecting thatch straw, are then placed horizontally along the face of the eave; and the third rope *c f*, loosened from the stack, is placed over these, and also passed below the eave-rope and brought up and passed behind itself like the two preceding ropes; and thus every rope all the way round the stack, at both ends of the 30 ropes, are treated. In carrying the ends of the ropes round the eave, they terminate successively till their length is exhausted; and it will be observed that, while the end of one rope fails to go beyond its length, the end of another one is gained, so that the band of ropes along the face of the eave remains of the same breadth round the stack. When ropes are so long as to become cumbrous, they are broken off. The last finish is made by bringing the ends of the 2 or 3 last ropes along the face of the eave, behind the 2 or 3 first ropes, where the finishing commenced. The stretch of the ropes between the eave and top are prevented from being shaken with the wind by 4 or 8 ropes being put on, as *a h b*, and *i k* and *i g* are, and which in

fact quarter the top of the stack, on their ends being fastened to the eave-rope.

4644. Of the cereal grains, barley is most liable to *heat* in the stack, partly owing to the soft and moist quality of the straw, and partly because clover is always mixed with it; on which accounts, it is advisable, in most seasons, to make barley stacks smaller than the others, both in diameter and height, and to build them upon bosses. Much care should be bestowed on building barley stacks to heat them properly, which is the best expedient to prevent heating. The least heat spoils barley for malting, and it should be remembered that malting barley always fetches the highest price in the market. Besides injuring the grain, heating compresses barley straw very firmly, and soon rots it. When a single stack only is seen to heat, it may be instantly carried into the barn and thrashed, the ventilation attending which will cool both grain and straw; but when a number show symptoms of leaning to one side, about 24 hours after being built, or exhibit a depression in the top, a little above the eave, you may suspect heating not only to have commenced, but to have proceeded to a serious degree. Incipient symptoms of heating are when moisture is observed on any part of the top of a stack early in the morning—delicately indicated on cobwebs—before the sun has evaporated it, or when heated air is felt, or steam is seen to rise. Heated barley lubricates the thrashing-machine with a gummy matter.

4645. Oats are less apt to heat than barley, though their heating is stronger. If the least sap remains in the joints of the straw, oats will be sure to heat in the stack. Heating gives to oat straw and grain a reddish tinge, and renders the straw quite unfit for fodder, and the grain bitter and unpalatable, both to horses as corn, and to people as meal.

4646. Wheat seldom heats, but, when it does, the heat is most violent. I never saw stacks of wheat heated but once, when they were foolishly led into the stackyard the day after being reaped. I cast down one of those heated wheat stacks, and such was the intensity of the heat that I was frequently obliged to come

down to the ground to cool my feet. Heated wheat is bitter to the taste, (1859.)

4647. Partial heating is induced in the compressed part where stacks lean over soon after being built. To prevent a stack leaning to one side, props, made of the weedings of plantations, should be *loosely* set around it, to guide its subsidence, especially if it has been rapidly built; but in using props, the caution is requisite, that, if one is pushed harder in than the others, it will cause the stack to swerve from it. Some stacks begin to sway the moment their top is finished, when props should be immediately set to keep them upright.

4648. To push a prop firmly into a stack requires the strength of two men, one to pull backwards between the stack and the prop, with both hands clasped upon the outside of the prop, the other to push forward with the shoulder planted against the outside of the prop, immediately below the other man's hands.

4649. As a safeguard against heating, a structure of wood is erected, around and upon which the stack is built. These structures are in Scotland named *bosses*, which signify hollows; and the object of using them is to occupy the space which would otherwise be filled with the collected heads of the sheaves of corn, with a void into which air shall be conducted from the exterior of the stack. When stacks are built on bosses erected on stathels, fig. 132, the air finds ingress into them through the frame-work of the stathel; but when built upon the ground, a conduit, in the form of a tressle, is formed of wood-work, by which the air is led into the interior of the stack. When such tressles are placed at both sides of a boss, a ventilation is maintained through the body of the stack.

4650. The most common form of boss is a three-sided pyramid, formed of three small trees, weedings of a plantation, of larch or Scots fir, tied together at the smaller ends, and the thicker ends placed at equal distances upon the stathel or the ground. Fig. 423 represents one of these common bosses, where the three trees are tied together at the top, at *a*, standing about 8 feet in height and 3 feet

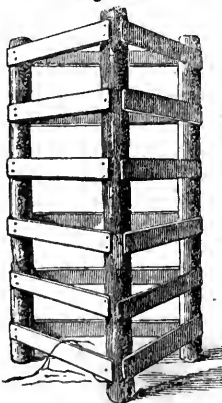
asunder from each other; and *b b* are fillets of wood nailed on the trees, for the
Fig. 423.



A PYRAMIDAL BOSS AND TRESSLE.

purpose both of retaining them in the pyramidal form, and of preventing the sheaves falling into the interior of the boss. A tressle *c*, about 2 feet high, is placed on one side to conduct the air into the boss. The inconvenience of this form of boss is, that, as the stack subsides, the sharp apex *a* penetrates through the sheaves lying above it, and, in thus disturbing their arrangement, disfigures the form of the upper part of the stack.

4651. Fig. 424 represents a form of boss which I prefer to this. It consists of 3 stems of trees,—



A PRISMATIC BOSS.

of weedings—7 feet long, held together in the form of a prism, whose side is 3 feet in width, by fillets of wood of that length being nailed to them. The prism is set on end, and on a stathel only requires to be nailed to it at the bottom; but as a farther means of stability, a spur from each tree should be nailed to the stathel within the prism. On the

ground it requires two tressles as well as the other sort of boss, to complete the ventilation of the air within the stack. This has the advantage over the other kind, of supporting the top of the stack evenly, when it subsides upon the upper end of the prism, relieving the body of the stack of the weight of its top.

4652. Other means than a boss are employed to form a hollow in the heart of a stack, by setting the upright sheaves which form the foundation of the stack, around a long cylindrical bundle of straw, firmly wound with straw-rope; and as the stack rises in height, the bundle is drawn up through its centre to the top where it is removed, leaving a hole through the height of the stack. This hole creates a current of air through the stack, allowing the heated air to escape, while the cool air enters from below by means of a tressle, or stathel.

4653. In wet weather corn is built in small stacks even in the stackyard; and should the weather prove settled wet, a dry moment should be seized to put 2 or 3 stooks into what are called *hand-huts* in the field, that is, small stacks built by hand, by a person standing on the ground. Sometimes corn is built on a headridge of the field, instead of being carried to the stackyard, as the same strength of men and horses will stack more corn there in a single fine day, than when it is carried to the stackyard; and the stacks derive more benefit from the air in the field than in the yard. Such stacks are also thatched in the field, and carried to the thrashing-machine during the winter. It is not an uncommon practice of some farmers to build a portion of their crop in the field every year; but the practice is not commendable in ordinary circumstances, as, besides the trouble and waste created in carrying straw for thatch to the field, much confusion and loss are experienced in carrying the corn to the steading in winter, when some of it cannot fail to be shaken out of the sheaves, and when the stacks wanted cannot, perhaps, be brought in for a tract of bad weather, or through deep snow. A scheme may be justifiable under peculiar circumstances which would be wrong in ordinary practice, and the building of stacks in the field is, one of them.

4654. The bundles of pease are turned in the field till they are win, and they become smaller by being tied with a wisp of their own straw. Pease straw is very apt to compress in the stack, and to heat, and should therefore be built with bosses, either in round stacks or oblong ones, like a haystack. The largest stack I ever saw was one of pease, at Beauchamp in Forfarshire, which was 150 yards in length; a tressle, under which a person could have walked upright, was erected through the entire length of the stack. When pease become very dry in the field before they are led, the pods are apt to open and spill the corn, particularly in sunny weather; and to avoid such a loss, the crop is usually brought quickly into the stackyard, and built on bosses.

4655. Beans are a long time of winning in the field in calm weather. As it is desirable to have the land they grow on ploughed up for wheat, they are not unfrequently carried to a lea-field and stooked upon it, till ready to be stacked. Being hard and open in the straw, they keep pretty well in small stacks, though not quite win; and the risk of keeping is worth running in dry weather after much rain, when the pods are very apt to burst and spill the corn on the ground. In building both pease and bean stacks, the sheaves are laid down with their corn end inwards, and tramped with the feet; and the stacks receive but little trimming, the pease none at all, the beans with the back of a shovel, fig. 83.

4656. The thatching of pease and bean stacks is conducted in the same manner as described for those of grain; but less pains are bestowed in finishing them off. As, however a good deal of corn is exposed on the outside of both pease and bean stacks, the thatching is not unfrequently brought down their legs, and kept on with straw-ropes.

4657. I would advise you not to imitate the practice of those farmers, who, because gratified to have their crops safe in the stackyard, seem regardless of the state in which the stackyard itself is left, after all the operations connected with the leading

in of the corn, and with the thatching of the stacks, are finished. It is left for a long time littered with the refuse of the thatching straw, which, when it becomes wetted with rain, is not only useless as litter elsewhere, but soon heats, and causes an unpleasant odour around the stacks. The spare straw should be removed, after it is of no use in the stackyard—that to the straw-barn which is drawn and bundled, and that to the sheds of the hammels which is loose, to be ready as litter for the cattle which will soon occupy them for their winter quarters. The ground should then be raked clean. After this cleaning, the air will become sweet, the stacks have free circulation of it amongst them, and the poultry will have the opportunity to pick up every particle of grain that may have fallen upon the ground. After such a necessary act of cleanliness is done, the stackyard gate should be closed, which brings the labours connected with the ingathering of the crop to a termination.

4658. Where rough grass grows on a farm, such as on a bog which is partially dry in summer, I would suggest its being mown and sheafed, for covering stacks. A day or two spent in mowing such grass, after the harvest is over, are well spent, even at the rate of wages and food of ordinary harvest-work. Not only does such vegetable materials save the drawing of clean straw when it is scarce, but of itself forms good covering for stacks which are soon to be thrashed; and by the time it has served the purpose of thatch, it becomes dry enough to litter courts. Bog-reeds, *Arundo phragmites*, might be used in the same way, where they do not find a profitable market as thatch for cottages. Every year I caused a large quantity of such materials to be mown, immediately after the reaping of the harvest was finished. The reapers enjoyed the work as a sport and relaxation on the winding up of the harvest, and the produce of their work added many tons to the manure heap.

4659. "The soil of the great Nankin cotton country," says Mr Fortune, "is not only remarkably fertile, but agriculture seems more advanced, and bears a greater resemblance to what it is at home, than in any part of China I have seen. One here meets with a farmyard containing stacks regularly built up and thatched, in the same form and manner as we find them in England; the land, too, is ridged and furrowed in the same way; and were it not for the plantations of bamboo, and the long tails and general costume of the natives, a man might almost imagine himself on the banks of the Thames."*

* Fortune's *Wanderings in China*, p. 126.

ON REAPING BUCKWHEAT.

4660. The buckwheat is a plant remarkably dependent on the weather. It requires dry weather immediately after being sown, and it springs up during the time of greatest drought. But after putting forth its third leaf, it requires rain for the development of its flowers. During the long time it continues in flower it requires alternate rain and sunshine, to enable the flower to set. The flower drops off in thunderstorms, and they wither in violent easterly winds. After flowering, the plant again requires dry weather to bring the seed to maturity.

4661. "The ripening of the grain is very unequal," says Thäer, "for the plant is continually flowering and setting. We must therefore cut it at the time the greatest quantity of grain is ripe. It sometimes happens that the first flowers do not set, or that they produce nothing but barren seeds, destitute of farina, while those which come out later yield better seed. But the grain will ripen, and even the flowers set, while the crop is lying on the ground after cutting, especially if rain fall. This occurrence is therefore considered favourable."*

4662. In the south of England a considerable period of both hot and dry weather is necessary in autumn to harvest it. It may be reaped with the sickle or with the scythe, or it may be pulled up by the roots—which last method is recommended by some, as less likely to shed the seed when fully ripe. In dry weather it should be reaped early in the morning, or late in the evening when the dew is upon it, and should not be moved too much in the day. It may be tied up in sheaves, or made into bundles like pease; but, in either way, it should be protected from birds, which are very fond of the seed.

4663. Owing to the thick knotty stems of the straw, the green state in which it is cut, and the late period it comes to harvest, a succession of fourteen or fifteen fine days are requisite to dry it sufficiently

for stacking. It requires turning and moving several times, in preparing it for the stack; and these should be done gently and in the dew, to disturb the seed as little as possible, as many of them will be lost, although the plant does not easily spoil when lying on the ground. To allow it to be early carried, it should be built in small stacks with bosses, (4651.)

4664. A considerable diversity of opinion exists as to the productiveness of buckwheat—Thäer considering 20 bushels an acre an extraordinary crop very rarely to be obtained; while Mr Hewitt Davis says that he has reaped 70 quarters from 12 acres, which is rather more than 46 bushels an acre.†

4665. The straw of buckwheat makes excellent fodder for cattle, as long as it is fresh; and the green plant, when raised with manure, affords such a forage in summer as causes a great increase of milk in cows, but it produces a stupifying effect on them. The green plant is also a valuable manure for wheat.

4666. No grain seems so eagerly eaten by poultry, or makes them lay eggs so soon and abundantly, as buckwheat. It is also relished by horses amongst oats. Its meal fattens both poultry and pigs. Its flour makes good unleavened cakes, which must be eaten fresh, as they soon turn sour. Its blossom is considered, in Flanders, to afford the best food for bees.

4667. "The farina of the buckwheat is yellow, like the pollen of the cedar," says M. Raspail. "The grains of its fecula are so small that they rarely attain to .0004 of an inch. The cellular texture which contains them breaks down under the pestle into angular fragments of .0055 to .004 of an inch in size, which, by their facettes and their yellowish appearance, resemble fatty grains. By a certain degree of maceration the grains of fecula may be rendered discernible the interior of these fragments.‡

4668. The import of buckwheat, for the year ending 5th January 1850, was 308 quarters; and of buckwheat meal 1095 cwts.§ (3472.)

* Thäer's *Principles of Agriculture*, vol. ii. p. 484—Shaw and Johnson's Translation.

† Davis' *Farming Essays*, p. 68.

‡ Raspail's *Organic Chemistry*, p. 122.

§ *Parliamentary Return*, March 15, 1850.

ON HARVESTING THE SUNFLOWER.

4669. When the stems and discs of the sunflower become withered, and the seeds shining and dark-coloured, the plant is ready to be removed from the ground. It may simply be pulled up by the roots—which in a strong crop, however, may require considerable force; but the stem may be easily cut over at the ground with a sharp sickle, fig. 392.

4670. The discs are afterwards easily cut off the stems with a sharp knife, and the seeds must be rubbed out with any suitable instrument, such as the Americans use for rubbing out the maize. Mr Lawson informs me that from 30 to 40 bushels of seed, per acre, may be deemed a fair crop of sunflower. These will yield 50 gallons of oil; the refuse will make 1500 lb. of oil-cake; and the stalks burnt into ash will afford half a ton of potash. Professor Johnston mentions that the seed yields 15 per cent of oil.

4671. "The seeds of both the common and dwarf sunflower (3475,) yield an oil little inferior to that of the olive for domestic purposes," says Mr Lawson. "In Portugal the seeds are made into bread, as also into a kind of meal; and in America they are roasted, and used as a substitute for coffee; but the purpose for which they seem best adapted is the feeding of domestic fowls, pheasants, and other game. The greatest objection to their culture is, that they require very superior soil, and are a most impoverishing crop, particularly the taller growing sort, *Helianthus annuus*; from which circumstance the dwarf species, *Helianthus Indicus*, has been preferred by some cultivators in France, who assert that, as its dwarf habit of growth admits of a greater number of plants being grown on a given space, it is not so much inferior to the other in quantity of produce, as, from its appearance, one would be led to expect.

4672. "In addition to the uses above mentioned, some French authors assert that the leaves, either in a green or dried state, form excellent food for cows, and that they are greedily eaten by them. The stems also form good fuel, and yield a considerable proportion of potash.*

ON HARVESTING MAIZE.

4673. About the 10th of September the entire plant of the maize assumes a dry straw

colour, but it should be left standing as long as the weather is favourable for ripening; and even an occasional day's rain or frost will not damage the grain.

4674. When ripe, the cobs should be pulled off the stem, thrown into the cart, and carried to the barn, where it should be husked as quickly as possible, else the grain will become musty. The cobs should not be pulled off at one time in larger quantities than what can be husked. Six people in the field—men, women, and boys—will, in one hour, break off the cobs with a downward pull, from two rows, and throw them into heaps on the ground, from one acre of maize. The same number of people require the same time to cut off one acre of the stalks by the ground with a sharp knife, and lay them in small heaps. The pulling off the cobs and the cutting down the stalks are done simultaneously. Carts then follow, the cobs are thrown into them, and the stalks are also removed to the dung stance.

4675. The husk is taken off in this manner:—In the evening of the day the cobs are brought from the field, three people, for every quarter of maize to be husked, sit down in the barn floor against, or if the heap is in the middle of the floor, around the heap, with their backs to the maize, and a two bushel basket before every four of them. Putting the hand behind, they pick a cob of maize from the heap, bring it before them, pull off the husk, spread it open, and whisk it off by the jerk of a little pointed stick, held in the right hand, and throw the husk on the floor before them and the head of maize into the basket. When the heap of husk before them rises to about two feet in height, the people face about and sit upon it, having the maize and the baskets before them, when they throw the heads of maize into the baskets, and the husks over their shoulder upon the heap. Two men carry away the baskets as they are filled, and empty them in a corner of the barn.

4676. So long as the heads of maize are kept in the barn, it is sufficient to turn them over occasionally, raising what is at the bottom of the heap to the top. Much

* Lawson's *Agriculturist's Manual*, p. 292.

air existing among the heads, there is no danger of the grain heating; but if not turned to change the sides, and let the damp out, the corn will acquire a musty smell. So treated, they will keep for any length of time.

4677. The grain may be taken off the heads, when in a fresh state, by pressing or rubbing them against any blunt-edged instrument, and after having been gathered two or three months, they may be beaten out with a stick or flail, fig. 350. In America, I believe, the heads of maize are put into a trough like a cart body, having both ends open, and a number of auger holes perforated in the bottom; and on their being beaten with a stick by a man at each end of the trough, the grain falls through the auger holes into baskets, or on the floor. One bushel may thus be beaten out in ten minutes.

4678. After the grain has been beaten from the heads, it should be kept in a dry place, where are both light and air, and frequently turned over; and here it may be kept for any length of time, if free of damp, and taken away as it is ground into meal, which ought to be used fresh, otherwise it soon becomes sour.

4679. The produce is about six quarters an acre. The bushel of maize weighs 60 lb., and affords 100 lb. of maize bread.*

4680. The husks of maize may be used to stuff mattresses, to make door-mats or brown paper. The pith of the cob makes excellent fuel, and the produce of an acre will furnish a family fire-lighting for a whole winter. The stalks, when burnt, afford the best smoking for hams. The leaves, as taken off in summer, when dried make a hay of the finest odour.

4681. The produce of an acre of maize may be estimated thus:—

6 quarters, at 28s. per qr., in 1850,	£8 8 0
10 cwt. leaf hay, at 3s. 6d. per cwt.,	1 15 0
Pith and stalk for firing,	0 10 0
	<hr/>
	£10 13 0

4682. Poultry fed on maize acquire a

high-flavoured flesh like the pheasant. When so fed, their eggs are of superior colour and flavour. Hams are in high repute from pigs fed on maize.

4683. In detailing the culture of buckwheat, maida, and maize, my object is not to recommend them as constituent crops of the farm—for I greatly fear none of them will find such a climate in the British isles as will allow their full development—and consequently, their product, whatever it may be, would not compensate for the labour and expense bestowed upon their culture; but, as the potato cannot now be depended on to yield a constant return, I would direct your attention to such crops as these, that, should you possess some favoured spot, enjoying a good soil and genial warmth, you might endeavour to raise one or all of them, and raise a supply of food for the poultry. That object is of less importance now, in 1850, that the price of oats and barley has descended so low, as to be only a little more than a halfpenny per lb., whereas maize here is three farthings. The ordinary grains of your own raising may therefore now be given to poultry without stint, as the cheapest food you have to give them.

4684. The average quantity of nutritive matter derived from an acre of maize yielding thirty bushels an acre, or 1800 lbs., is of husk or woody fibre 100 lb.; starch, sugar, &c., 1260 lb.; gluten, &c. 216 lb.; oil or fat from 90 to 170 lb.; and saline matter 27 lb.†

4685. America is the great field for the culture of maize, and of the United States, Kentucky, Tennessee, and Ohio raise much the largest quantity of any of the other counties in the States. The quantities raised in the entire Union were as follows:—

In 1841	387,380,185 bushels.
... 1842	441,829,246 ...
... 1843	494,618,306 ...
... 1844	421,953,000 ...
... 1845	417,899,000 ...

4686. The money value of the produce of 1845, 417,899,000 bushels at 25 cents, is 104,474,500 dollars; and reckoning 5 dollars to L.1 British currency, the amount is L.20,894,900. The quantity of maize raised, as compared with wheat, is in the ratio of 4 to 1, on account of the growing fondness of the people for it as an article of food, more than for exportation.‡

* Keene's *Facts for Farmers*, p. 8-16.

† Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 928.

‡ *Journal of Agriculture*, March 1850, p. 860-2.

4687. "Almost all the grains of the fecula of the maize," observes M. Raspail, "are damaged by the mill, on account of the great hardness which the seeds acquire by drying, from the oil, the gum, and the sugar they contain. The greater part are agglutinated together, and present the appearance of a cellular texture, with small meshes. They are folded, and more or less wrinkled and irregularly rounded. The largest of them scarcely exceed .000,98 of an inch, and but few are so large. But if, instead of examining this fecula as it is found in the farina, it be taken out of the unripe seed when the perisperm is, so to speak, yet milky, the grains have a totally different appearance. They are perfectly spherical, smooth, and entire; and it appears to me that more fecula could be obtained, by expression of the seeds a little before they are quite ripe, than by grinding the ripe seeds. For by the former method the unruptured grains fall to the bottom of the liquid; while in the latter, being torn and bruised by the mill, they give out their soluble substance to the water, and remain suspended in the liquid, being as light as simple membranes. This is the reason why Parmentier, who analysed the farina of maize by the second mode, obtained so little fecula from it."*

4688. The import of maize, for the year ending 5th January 1850, exceeded that of 1848, being 2,249,571 quarters; but the import of Indian corn meal decreased in that period, being 102,181 cwt. (3495.)†

ON THE COMMON JERUSALEM ARTICHOKE.

4689. Although some farmers raise the common Jerusalem artichoke to feed their pigs with, and as a relish to their horses, for which purposes it is well adapted, I have refrained to recommend it for culture in the fields, because when it gets possession of the land no weed is so difficult to eradicate. Where a piece of ground is detached, and is not appropriated to a better purpose, this plant might be cultivated; and its culture is in all respects like that of the potato on the flat ground in every third furrow of the plough. (2774.) Its stem rises from six to ten feet in height, and when it has withered it is cut off, and the crop raised out of the ground by means of the spade or graip. The tubers may be pitted, but are more conveniently stored in an outhouse when in daily use by stock. They should be cooked before being given to the pigs.

4690. The Jerusalem artichoke, *Helianthus tuberosus*, occupies the same place in the botanical system as the sunflower, (3475.) Its leaves are rough; stem six to ten feet in height; root tuberous; perennial; native of Brazil; introduced in 1617. Seldom or never produces its flowers, which are yellow, in this country, except the tubers be carefully removed when they begin to form. The name Jerusalem is a corruption of Girasol—turning to the sun—an imputed property to this genus of plants.

4691. "Before the introduction of the potato into this country," observes Mr Lawson, "the common Jerusalem artichoke was held in much esteem, as it is even yet on the Continent. Fowls, particularly pheasants, are remarkably fond of its tubers, as are also swine, cattle, hares, rabbits. The tubers are produced in considerable quantities; and as they are not liable to be injured by slight frosts, their limited cultivation, instead of potatoes, for feeding the above mentioned live stock, has been recommended. They might also be planted in woods and waste places, on good lightish soil, not too much shaded, as winter food for game. The tubers, as is well known, are also eaten at table, cooked in various ways."‡

4692. "When the bulbous roots of the Jerusalem artichoke are bruised and expressed, a mucilaginous liquid is obtained. When heated to 212°, this liquid coagulates so strongly, that it may be employed to clarify other liquids."§

4693. The ash of the tubers of the Jerusalem artichoke, according to Boussingault, consists of the following ingredients:—

Potash,	.	.	.	54.67
Soda,	.	.	.	traces
Lime,	.	.	.	2.32
Magnesia,	.	.	.	2.21
Oxide of iron, alumina, &c.,	.	.	.	6.39
Phosphoric acid,	.	.	.	13.27
Sulphuric acid,	.	.	.	2.70
Chlorine,	.	.	.	1.97
Silica,	.	.	.	15.97
				100.00
Percentage of ash in the dry state,				6.00 ||

ON THE BIRDS DESTRUCTIVE TO THE GRAIN CROPS.

4694. Of late years the opinion seems to gain ground, that birds do more good to the farmer and gardener, by devouring destructive insects, than harm in eating and spilling every kind of seed. A closer observation of the habits of birds may have

* Raspail's *Organic Chemistry*, p. 120.

† *Parliamentary Return*, 15th March 1850.

‡ Lawson's *Agriculturist's Manual*, p. 234. § Thomson's *Organic Chemistry—Vegetables*, p. 843.

|| Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 384.

caused such a change in opinion, and it is conducive to the cause of truth that observations on the subject have been made; for the prevalent opinion formerly was, that every bird which consumed grain did so much unmitigated mischief; whereas it is now ascertained beyond doubt that every bird feeds its young on animal, and not entirely on vegetable food. Like most changes of opinion, however, this one is likely to reach the opposite extreme, and the tendency at present inclines to the denial of birds doing any damage to the products of the fields—always excepting game birds. The confirmed truth is, that birds are neither entirely insectivorous nor entirely granivorous, but that they generally feed their young with insects and molluscs, while the adult bird itself eats such fruits and seeds as are found to their liking in the products of the gardens and the fields. This being the real state of the case, let us consider which of the birds are most destructive to grain in the fields.

4695. The greenfinch, *Linaria chloris*, in the seed season, accompanied by their young brood, will attack almost every sort of seed that is ripe or ripening, but are more particularly destructive to turnip-seed and flax, where these are grown, and to oats among the ordinary grains. Oat fields, and even wheat fields near woods and hedges, suffer considerably, the greenfinch being a great eater, its bill being seldom idle, shelling and munching from sunrise to sunset.

4696. The yellow-hammer, or yellow-yite, *Emberiza citrinella*, prefers for its own eating grain and seeds, particularly oats; and in new-sown fields of oats, as well as wheat, it may be seen busily picking up the grain from the moment it is sown till the period of its braiding. By autumn, when the broods are reared and the corn crops begin to ripen, they assemble with sparrows and corn-buntings, and other plunderers, which leave little alongside the hedges but empty husks on the standing straw. When feeding in the stubble fields, they advance by very short leaps, with their breasts nearly touching the ground; when apprehensive of danger, crouch motionless; and when alarmed, give intimation to each other by means of their ordinary short note. They are gene-

rally more shy than the chaffinches but less so than the corn-buntings.

4697. The seed-bunting, or black-bonnet, *Emberiza schaniculis*, mostly lives on seeds, though the small patches of oats on the crofts in the upland districts are almost certain to attract its notice; and flocks of black-bonnets will devour the half-ripened oats on such moorland crofts as late as October. Not being shy, it is not easily scared from its food. It is migratory in most parts of Scotland, departing in October, and reappearing in the beginning of April.

4698. The corn-bunting, *Emberiza miliaria*, feeds wholly on grain, and in early spring, together with the yellow-hammer and others, devour considerable quantities of the newly sown seed-corn, particularly oats and barley. After the breeding season it feeds on the ripening seeds of beans, pease, wheat, oats, and barley, while during the autumn it feeds on the stubble lands; and at this season it sits as close as the skylark, although it is usually shy. It does not omit to visit the new-sown wheat on the fallows and after potatoes. In winter it becomes remarkably fat, and is superior as an article of food to most of our small birds. "It could hardly be supposed," observes Mr Knapp, "that this bird, not larger than a lark, is capable of doing serious injury; yet I this morning witnessed a rick of barley, standing in a detached field, entirely stripped of its thatching, which this bunting effected by seizing the end of the straw, and deliberately drawing it out to search for any grain the ear might yet contain; the base of the rick being entirely surrounded by the straw, one end resting on the ground, and the other against the snow, as it slid down from the summit, and regularly placed as if by the hand; and so completely was the thatching pulled off, that the immediate removal of the corn became necessary. The sparrow and other birds burrow into the stack, and pilfer the corn; but the deliberate operation of unroofing the edifice appears to be the habit of the bunting alone." Such a circumstance as this shows the risks which stacks built in the field run, when they might have been safely secured in the stackyard.

4699. The common skylark, or laverock, *Alauda arvensis*, is much more destructive than the corn-bunting, both to the newly sown seed-corn and the ripening crops, inasmuch as the species is greatly more numerous; but who would grudge the laverock all that he can glean from the fields? In winter larks assemble in vast flocks, grow very fat, and are taken in great numbers for the table. They cannot be considered of much importance as an article of food, yet vast numbers are sent to our markets in winter, especially in London, and some other English cities; but in Scotland they are in little request. They taste well—not better, however, than the corn-bunting, and are decidedly inferior to the blackbird, fieldfare, and thrush. At Bonneville, on my way from Geneva to Mont Blanc, I was obliged to dine on larks for want of more substantial fare.

4700. The grey or brown linnet, rose linnie, *Linaria cannabina*, does much more damage to corn than is generally supposed. In the first place, it visits the patches of fields of turnips left to ripen for seed, (4188,) and then frequents the newly sown turnip-fields. When the young families begin to wander in small companies as the grain becomes ripe, they devour large quantities of the standing corn, voraciously living upon it from the moment it begins to whiten until led to the stackyard. After this period the smaller families associate in larger flocks, frequently combining with the greenfinch, and subsist on the stubbles, until the autumn wheat is sown, when they frequent the newly sown fields and thin the seed-corn in detached patches so much, that the scantiness of the braird is ascribed to the attacks of some grub. This linnet, however, is easily scared by watching.

4701. The chaffinch, shilfa, *Fringilla cœlebs*, frequents the vicinity of houses in the autumn, searching for food in the fields and farmyards, which consists of seeds of various kinds, but especially of oats and wheat. As the winter approaches, they collect in large flocks, and associate with greenfinches, grosbeaks, yellow-hammers, and sparrows, and other species of this order frequenting the farmyard, and settling on roads

to search among horse-dung for undigested grain. The chaffinch devours more seeds of weeds than of grain, and in that respect is useful in keeping them down, and may be ranked as a benefactor to the farmer on the same footing as the goldfinch, *Carduelis elegans*. Dr Bechstein says “that the passion for this bird is carried to such an extent in Thuringia, and those which sing well are sought for with so much activity, that scarcely a single chaffinch that warbles tolerably can be found throughout the province. In Rhul, a large manufacturing town in Thuringia, the inhabitants, who are mostly cutlers, have such a passion for chaffinches, that some of them have gone ninety miles from home to take with bird-lime one of those birds, distinguished by its song, and have given one of their cows for a fair songster; from which has arisen their usual proverb—*a chaffinch is worth a cow*. A common workman will give as much as 16s. for a chaffinch he admires, and will willingly live on bread and water to save the money for this purpose.*” The peasantry of this country do not regard the song of the chaffinch as remarkably attractive.

4702. The house-sparrow, *Passer domesticus*, is a well-known depredator in our corn-fields. As the crop ripens, it feeds upon grain and pease, which it abundantly obtains during several weeks in autumn on the standing corn, and less profusely supplied in winter when it searches the stubbles. As Buffon observes, “sparrows follow the sower in seed-time, and the reaper in harvest; they attend the thrasher at the barns, and the poulterer when he scatters grain to his fowls; they visit the pigeon-house and pierce the craws of the young pigeons to extract the food.” It is supposed that a sparrow eats its own weight of corn every day, when it can get it for the taking; and Buffon estimates that a pair of sparrows will eat 20 lb. of corn every year. When as many as 3000 have been caught on one farm in a single day with a net, one may calculate from such data the quantity of grain they consume on a single farm.†

4703. These are the principal small or passerine birds which infest the corn-fields.

* Bechstein's *Cage Birds*, p. 183, note. † *Quarterly Journal of Agriculture*, vol. vii. p. 284-98.

Others of a larger description also frequent such haunts, and among these the common pheasant, *Phasianus colchicus*, is accused of committing great havoc amongst grain crops. Its true habits are thus described by Professor Macgillivray: "Its favourite places of resort are thick plantations or tangled woods by streams, where, among the long grasses, brambles, and other shrubs, it passes the night, sleeping on the ground in summer and autumn, but commonly roosting on the trees in winter. Early in the morning it betakes itself to the open fields to search for its food, which consists of the tender shoots of various plants, grasses, bulbous roots, roots of grasses, and *Potentilla anserina*, turnip tops, as well as acorns and insects. In autumn, and the early part of winter, it obtains a plentiful supply of grain, acorns, beech mast, and small fruits. In severe weather, however, especially where great numbers are kept, the pheasants require to be fed with grain, when they learn to attend to the call of the keeper." In the natural state, and in small numbers, pheasants prefer insects and the young shoots of plants, to corn, of which they pick at a time only a few grains; but when semi-domesticated, and congregating in large numbers, they assume the habits of the domestic fowl, and will eat and trample down extensive patches of the growing corn, in the immediate vicinity of their preserves—and this they do between the ripening and the reaping of the crop. The remedy against their destructive effects is to restrain their numbers within moderate bounds. Their numbers have multiplied greatly in Scotland within my recollection, and are now certainly too numerous even for sport.

4704. A far more destructive bird, individually, than the pheasant, is the ringed dove, or cushat, or wood-pigeon, *Columba palumbus*. Its powers of destruction may be estimated by the wholesale levy it makes on the products of the fields and of the woods, as thus enumerated by Professor Macgillivray: From its roost in the larger branches of trees, "it issues at sunrise to search the open fields for its food, which consists of seeds of the cultivated cereal grasses—wheat, barley, and oats; as well as of leguminous plants—beans and

pease, and of the field-mustard and charlock. In spring it also feeds on the leaves of the turnip, and picks the young blades of the red and white clovers. At this season, I have several times found its crop distended with the farinaceous roots of *Potentilla anserina*, obtained in the ploughed fields. This root is highly nutritious; and formerly, in seasons of scarcity, was collected in the West Highlands and Hebrides as an article of food, and eaten either boiled or roasted in the peat ashes. In summer they eat grass, and other vegetable substances; in autumn, grain, beech-mast, acorns, and leguminous seeds. The beech-masts and acorns they swallow entire, their bill not being sufficiently strong to break them up."*

4705. The wood-pigeon destroys the growing crop in this manner, as described by an eyewitness:—"The wood-pigeon has a weak bill, but nature has provided her with very strong wings; when the flock, therefore, settle upon the lying portion of a wheat field, instead of breaking off the heads and carrying them away, they lay themselves down upon their breasts upon the grain, and using their wings as flails, they beat out the pickles from the heads, and then proceed to eat them. The consequence is, that, the pickles having been thrashed out upon a matting of straw, a great proportion of them fall down through it to the ground, and are lost even to the wood-pigeon: in short, they do not eat one pickle for twenty which they thrash from the stalk. I have repeatedly watched this process from behind the trunk of a large willow tree, growing in a thick-set hedge on the edge of a wheat field, and seen the operation go on within a couple of yards of me. The pigeons descend first singly; but, having left a watcher upon the highest tree in the neighbourhood, the whole flock are soon at work on the same spot, and the loss of grain to the farmer is very great. They are also gluttons in quantity."† This bird has increased to incredible numbers in Scotland within the last thirty years.

4706. The common partridge, *Perdix cinerea*, doubtless devours grain in the

* Macgillivray's *British Birds*, vol. i. p. 123 and 263.

† Burn Murdoch's *Observations on Game*, p. 11.

fields; but however plentifully it may breed in any locality, it leaves no marks of its effects upon any crop, and is always a favoured bird with people in the country.

4707. The rook or crow, *Corvus frugilegus*, has a bad reputation amongst farmers, and not without cause; for however sedulously it will follow the plough and harrow, in search of worms and insects, as long as it has to support its young, there is no doubt that, after that period, it becomes omnivorous, and will eat anything that comes in its way. It will pick meat clean off the bone—it will pick horse-flesh, as long as it is fresh—it will eat fish—it will go to the sea-coast in search of shell-fish, when food is scarce on the land—it will carry off and eat the stray eggs it may happen to find at the steading—it will eat the boiled potatoes and oatmeal porridge set down for the poultry—and when a bowl of barley broth comes within its reach, it will soon empty it, and the sooner, the thicker the barley is in the broth—it will eat the boiled barley and pease out of the horses' mash-tub—it will take up the young plants of potatoes after they have sprouted for their own sake, being then in a sweet state, (2809,) and not merely in search of any insects in them, as I have particularly determined—it will pull up the young plants of turnips, to get at insects that may happen to be near their roots in the manure, and it is poor consolation to the farmer to be told that the plants were destroyed that insects might be captured—it will eat fruit off the trees—it will alight upon laid corn of all kinds, and pick and scratch out much more than it can eat—it alights also on stooks of corn, and pulls out the ears, and eats the grain—it will fly to a great distance to eat the crowberry, *Empetrum nigrum*—it will break into the heads of stacks to get at the grain; and in this respect Mr Waterton is not correct when he says that, "in winter, the rooks will attack the corn-stacks which have lost part of their thatch by a gale of wind."* And he takes the occasion to rebuke the farmers of Yorkshire for being slovenly in delaying to repair the damage done by the wind; whereas, if he had observed more closely and accurately, he would have

learnt that the wind first breaks a stack at the eave, and not at the top, while, on the other hand, the top is the very part the rook always breaks into, because it knows, probably by the smell, that the heads of sheaves stand accumulated there. These are all facts which I have myself observed of the rook, and they are sufficient in number to support the assertion that it is a destructive bird to the farm. At the same time, the rook, in moderate numbers, would do no material injury in the fields, and it is only when it is nourished in excessive numbers, in large protected rookeries, that it does sensible injury. It is no palliation of their injury that rooks do no greater injury in the neighbourhood of large rookeries than elsewhere, for, although they may not feed near their rookeries, they must go to find food somewhere. He who asserts that the rook does no harm to crops, and does good alone by the removal of insects from the soil, must either be a prejudiced or inaccurate observer of its habits.

4708. As to insects existing in the ground, there must be very large numbers in it every spring; and of those which might do harm to crops, that are removed from the soil, by whatever means, the agents that remove them save the crops to that extent. But it does not follow that, because insects always exist in the soil, they must necessarily injure the crops sown in it; for, if they did, since insects always inhabit the soil, the crops would invariably be injured to the same extent every year—a result not in accordance with the experience of any farmer. My belief is, that it is only when insects increase in any year, by circumstances unusually favourable to their existence, beyond what their ordinary food will support them, that they subsist on the sown corn to an injurious extent. That some corn is every year devoured by insects in the soil is a matter beyond doubt, and the loss not being estimable any season, it is not complained of.

4709. Many devices have been formed to scare destructive birds from corn-fields and green crops, and the most common one is the *scarecrow*. Scarecrows are made of various forms and materials; but

* *Journal of Agriculture*, July 1844, p. 505.

we all know that every tatie-doolie or shoy-boy is habited in the similitude of men or women. Pieces of bright tin are made to flicker in the sun-beams, at the end of a string. Lines of threads are hooked on from one object to another. But as soon as birds become familiarised with the permanent form of any scarecrow, it loses its terrors. The contempt shown for them by birds is thus described by Cobbett, in his own peculiar manner: "Shoy-boys," he observes, "exercise their influence but for a very short space of time. The birds quickly perceive that their guardianship of the treasures of the farmer is a mere *sham*; and, like the sparrows in my neighbour's garden at Botley, they will, in a short time, make the top of the hat of a shoy-boy a table, whereon to enjoy the repast which they have purloined."

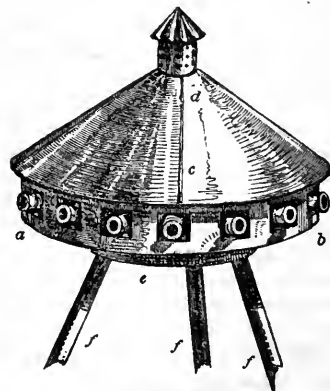
4710. Poison has been recommended for the destruction of sparrows, but in taking their lives by this means, the lives of valuable birds might be destroyed at the same time. Where ivy is plentiful, in which sparrows delight to harbour, a net has captured as many as 3000 in one day. Sparrows are easily shot with a gun loaded with sparrow-hail, when congregated on a bare piece of ground, lured thereon by a favourite sort of food being strewed upon it.

4711. In regard to the use of poison in killing birds, Dr Taylor makes these observations in answer to the important query, "*Is the flesh of poisoned animals poisonous?*" This is a question which it is necessary to consider, because poultry and game are not unfrequently poisoned wilfully or accidentally, and in this state they may be eaten unsuspectingly. It is well known that grain is often saturated with a solution of arsenic for agricultural purposes before it is sown: if this grain be eaten by poultry, it will destroy them; and a question may arise as to the effects which the flesh of the animals so poisoned is liable to produce on man. In other instances, poison has been placed in the way of these animals with the malicious object of destroying them. Thus oats saturated with arsenic, or with that poison intermixed, have been placed in game pre-

serves, for the purpose of destroying pheasants and other birds. During the last spring, (1846,) two blackcocks were sent to me for examination from the extensive preserves of a nobleman in Scotland. They had been found dead on the ground. A quantity of arsenic was discovered intermixed with oats and the shoots of the larch in the crops and gizzards of each bird, and arsenic also existed in the pectoral muscles and soft organs. There had been previously a very large destruction of game on the estate, as it was inferred, from poison. There is hardly a doubt that, when the animal dies soon after the ingestion of poison, and obviously from its effects, the flesh would be poisonous to man, although it might require a large quantity of the flesh to produce a fatal result. Professor Christison reports a case which renders this opinion highly probable.*

4712. Gunpowder is the most effectual means of any of scaring birds from fields, (2809.) Rags steeped in a solution of gunpowder, dried, and placed on the windward side of a field, will act as a scare as long as they last, but the renewal of them is a troublesome business. I contrived an apparatus, which I named a *rook-battery*, to keep up a fire throughout the day, with little trouble. It is seen in perspective in fig. 425. It consists of a cir-

Fig. 425.



THE ROOK BATTERY.

cular plate of strong tin, *a b*, eighteen inches in diameter, upon the circumference of which is soldered a hoop of equally

strong tin, three inches in height, and through which are pierced twenty-four embrasures, three quarters of an inch square each, at equal distances from one another. At each embrasure is mounted a brass cannon, four inches in length, upon a carriage soldered to the bottom plate, and removable at pleasure by means of a clasp. The plate and rim are covered by a conical tin top, *c*, similar to the cover of a street lamp, with an eave projecting one inch to prevent the drip of rain running down the rim. The cover is surmounted with a cylindrical lantern *d*, $2\frac{1}{2}$ inches high, pierced with holes. The cannons are loaded with fine gunpowder, and wadded with woollen wadding to prevent its ignition. They are fired with a match consisting of cotton thread dipped in a solution of saltpetre; and the thread is brought over and held upon the touch-hole of each cannon, by a bit of copper-wire attached to the carriage. The match-thread is made longer and shorter as the time is determined on between the discharge of each cannon; and to dispose of it for this purpose, the central part of the plate *a b* is divided by perpendicular partitions of tin, so arranged as to form numerous alleys, along which the match-thread is made to traverse at that length as to burn it down in time to reach the touch-hole at the given hour. Plate *a b* is affixed to a circular board *e*, nine inches in diameter, and one inch in thickness; and in its circumference are attached three legs, *f f f*, which support the apparatus in tripod form, at a height to elevate the apparatus above the standing corn. The battery is placed in the part of the field most frequented by the rooks, and where it may best be seen. Suppose that the guns are loaded and the match lighted at five in the morning, and that by eight at night it is time to cease firing, which is fifteen hours, in which time thirty-seven and a half minutes will require to elapse between the discharge of each of the twenty-four cannons. Such discharges are much more to be depended on for regularity than the firing of any fowling-piece by a herd-boy. In addition to the discharges of the guns, if a piece of woollen rag, steeped in a solution of gunpowder and dried, were placed in a cup of tin at *d*, immediately below the lantern of the cover, and set fire to, the smoke arising from it would still fur-

ther intimidate the rooks, and cause the discharge of the cannons at longer intervals to suffice. Both these means would also intimidate pigeons and small birds. The position of the battery should be changed every day, and a piece of laid corn is the best spot for erecting it on, to be most seen from a distance. It may be set amongst potatoes, as also in a plot of turnips growing for seed, (4188.) The number of such an apparatus required for a farm would depend on the number of the corn-fields subject to the attacks of birds, and also on the succession in ripening of the different crops. Batteries could be made of any size, and to fire as often as desired; and the smaller-sized ones, when longer in use than all the cannons can reach the time, the cannons might be loaded oftener than once a-day.

4713. No wild birds are so destructive to standing corn as the poultry of all kinds at a farm-stead. Hens pull down the standing stalks of corn, and, after shaking a few grains out of an ear, leave it and pull down another stalk; and where the corn is laid they scratch the straw and ears with their feet, and cause many more grains to come out than they consume. Turkeys, being tall, are fully more destructive than hens, and are less easily satisfied. Geese pull down standing corn, and nibble the grain out of the ear; and being stout birds they munch the ears pretty clean of the grains, but they trample laid corn quite flat, and entirely destroy the straw. Ducks usually content themselves in shovelling off the ground the grain the hens and turkeys have spilt, but they also trample laid corn flat. The common pigeons rest much on the laid particles of wheat, and pick the grains clean out of the ears by shaking them in their bills, when numbers of the grains fall between the straws to the ground, (1606.)

4714. The only means of saving the growing crops near the steading from destruction by the poultry, is to confine them all within the steading for a period before the corn is ripe, until it is cut down, as they do comparatively little harm to stooks. An excellent and convenient place to confine them in summer is in the court I, in the Ground-plan of the steading on Plate II., which should

be covered over with netting. The sheep nets, fig. 44, will answer the purpose by lashing their edges together, and suspending them as high as to allow a person to walk under them. Subdivisions could be made both in the shed D as well as in the court, by means of hurdles, fig. 40, to keep the different sorts of poultry separate from each other. Food and water must be given them daily while under confinement, as well as sand and gravel to swallow, and dry earth or ashes to burrow in, and no harm can overtake them. If a number of the courts of the hammels M were covered over with netting, they would form convenient divisions for separating the different classes of poultry. Thus the farmer possesses ample means of accommodating the poultry in the steading at a season when it is not occupied by the other stock, and thus saving the crops of the neighbouring fields from destruction. The value of all the corn and straw destroyed by poultry may not amount to much in value, and it will cost as much, and more perhaps, to maintain them under confinement; but the neglectful management evinced in allowing the poultry to roam at large when the temptation of a corn field is near, is discreditable to every farmer.

ON PUTTING THE TUPS TO THE EWES.

4715. When the 8th to the 11th of October has arrived, the tups should be put amongst the ewes for the purpose of producing lambs to support the standing flock of the farm, as also for disposal in the market.

4716. The ewes now tupp'd may be expected to lamb (2546) about the 8th to 11th of March following—the period of gestation of the ewe being 5 months, or at least 151 days.

4717. About the beginning of October the skin on the flanks of the tups (924) becomes red, which is best observed when the animal is turned up; and this redness is the certain and only symptom that the tups feel the desire to serve the ewes.

4718. The gimmers, (924) as well as the ewes, (925) are put to the tups at this

time; but only those gimmers and ewes which have been selected from the drafted ones (4007) are put to the tup. In a small flock, when both gimmers and ewes do not exceed in number what one tup can serve, they are classed together to be served by the same tup; but in larger flocks the gimmers and ewes are kept separate during the tupp'ing period, and served by different tups.

4719. Both the ewes and gimmers should have been for two or three weeks on fresh grass, or rape, before the tup is put to them, in order to bring the season upon them more quickly and simultaneously, (4011.)

4720. Before the tups are put to the ewes, the under part of their brisket is coloured with keil or ruddle, (3501,) in order to let the shepherd know which ewe he has served by leaving the red mark of the keil upon her rump. The keiling requires to be daily renewed when the tupp'ing is active, and when the weather is damp.

4721. A shearling tup (925) will serve 60 ewes or gimmers, and an aged tup 40; and these numbers should never be exceeded when produce is desired to be strong and healthy. When tups are too fat they become lazy, and serve the ewes reluctantly; and when such is the case with a favourite tup, he should be put with a few ewes into a small paddock of grass, where he will have little occasion to travel about. Gimmers are more restless in the serving than ewes, on which account, should an aged tup serve them, he should receive the fewer number. Tups that have served ewes long are apt to become spavined in the hind hocks, in consequence of having to sustain the great weight of their carcass in the act of serving.

4722. Tup-hoggs (924) are never allowed to serve ewes or gimmers, not having attained maturity in any particular; though one is at a time made to stimulate the activity of an aged tup; and whenever he dares approach a ewe, he is driven off by the old fellow. To prevent him effectually from serving a ewe, a piece of cloth named a *brat*, or apron, is sewed to the wool below his belly.

When particular ewes are not desired to be served until a specified time, a piece of cloth is sewed on the wool behind them, to hang over the tail. When fastened on below the tail, as is sometimes done, the ewe is interfered with in making water.

4723. Tups are not selected for ewes by mere chance, but for such qualities as may improve those in the ewes. When ewes are nearly perfect, they may be selected for breeding tups. A good ewe flock should exhibit these characteristics:—*a strong bone*, which, supporting a roomy frame, affords space for a large development of flesh,—*an abundance of wool of good quality*, which clothes all the body in inclement weather, and insures profit to the breeder,—*a disposition to fatten early*, which enables the breeder to dispose of his draft-sheep readily,—and *prolificacy*, which increases the flock rapidly, and is also a source of profit. Each one of these properties is advantageous in itself, and when all are combined in the same individuals, the flock has attained a high degree of perfection.

4724. In selecting tups, you should observe whether or not they possess one or more of the above qualities, in which the ewes may be deficient; and if they do, their union with the ewes will produce in their progeny a higher degree of perfection than exists in the ewes themselves. But, should the ewes be superior in all points to the tups examined, no such tups ought to be used, as they will certainly deteriorate the progeny, part of which will have to make up the future ewe flock.

4725. Most of the ewes will be tupped by the second week the tup has been amongst them, and in the third week they will all be served. It is likely that some of the first served ewes will return in season, and will have to be tupped again amongst the last served, the season returning on ewes in a fortnight. When ewes do not return in season, it may be concluded that they are in lamb; and those which again exhibit symptoms of season, after being served again, at an interval of a fortnight, will not likely be in lamb, and will become tup-eild or barren ewes, (929.)

4726. It is the duty of the shepherd to

notice what ewes are tupped in succession, and which of them return in season, that he may know the succession in lambing of every ewe, (2546.)

4727. After 3 weeks have elapsed from putting the tup amongst the ewes, he should be withdrawn; as lambs begotten so long after the rest, will never coincide with the flock. After serving, tups should be put on good pasture, as they will have lost much of their condition, feeling indisposed to eat their ordinary quantity of food during the tupping season.

4728. The ewes and gimmers may now be put together on such ordinary pasture as the farm affords. During the autumnal months they will find plenty of food on such; and for the winter, a rough pasture-field should have been reserved for them. When none such has been reserved, they will require a few turnips every day; but you should bear in mind, that a *fat* ewe always bears a small lamb, (2565.) and is very subject to inflammatory fever after lambing; and from the recovery of which will probably have a scantiness of milk. Swedish turnips produce fatness on ewes more readily than other kinds, so that white turnips should be reserved for them should they receive turnips at all; but the rough pasture is greatly more for their advantage than any turnip, and a little oil-cake, 1 lb. a-day to each in addition, will bring them through any period of severe weather.

4729. On carse, dairy, and pastoral farms, on which only wethers are reared, as also on farms in the neighbourhood of large towns, no standing flock of breeding ewes are kept.

4730. On pastoral farms on which breeding is pursued, a standing rule should be, not to put the tups to the ewes till such a period that the lambs may not appear in spring before a sufficiency of food is found to support the ewes.

4731. On the middle district of mountain pasturage, the Cheviot breed is chiefly bred in Scotland; and their tupping season is from the 15th to the 22d of November, with the expectation of receiving lambs from the 15th to the 22d of April.

4732. A few days should always be allowed to elapse before the tups are put to the gimmers, because, being less able than ewes to endure the hardships of lambing and of giving suck, their lambing season should be the longer postponed, until the weather is milder, and the pasture yields more nourishing food.

4733. The number of ewes or gimmers to a tup should be 60, but where the grazing is more than ordinarily steep, a smaller proportion of ewes would be advisable.*

4734. In regard to the management of Black-faced sheep on the highest mountain districts, the following observations of Mr Little are very sensible:—"Taking the seasons on an average," he says, "since I had anything to do with sheep, and the average of situations where I have had opportunities of making observations, I consider the 27th November as being the most proper time for letting the tups to the ewes. Those whose situations are favourable for an early lambing-time, might let the tups to the ewes a week sooner; but very few breeding mountain stocks will derive advantage by their being let so early, as what is gained in size and strength by the lambs is lost in condition by the ewes. Besides, there is a greater risk of bad weather and less grass, than when the lambing season is later. In bad situations, a few days or a week later in the lambing-time ought to be preferred, as safest for preserving the condition of the ewes and the lives of the lambs; and although the lambs should be a little younger, they can be allowed to suck a little longer, as the ewes are able to afford milk, without injuring themselves, when the land is full of grass, than in a barren spring. Besides, those farmers that have least grass in spring have most in autumn, and this brings them nearly on a level with farms that have early grass, taking the whole year round. Whatever time the tups are let to the ewes, all the ewes that are intended to bring forth lambs the same season ought to be let to at the same time, as the best time for the young and lean is certainly the best for the others. . . . Every shepherd knows that, among hill sheep, the ewes are much more kindly to their lambs, and careful about them, when they are themselves in good condition and have plenty of milk, than when low in condition and scarce of milk. The later in the season that lambing-time is, they have a better chance of being in good condition, and having plenty of milk; and it rarely happens that the older lambs are the best at weaning time."†

4735. Threescore ewes will be enough for one tup, and tups should never be longer than four or five weeks with the ewes, as every ewe tupped later than that period is injured for the ensuing season, and her lamb never turns out to good account.

4736. When overstocking mountain pasture prevailed some years ago, so scanty was the food for ewes in late seasons, that thousands of lambs were swept away with a fatal mortality, and the ewes also perished through the diro disease of the hunger rot; but now, when mountain pasture is stocked, like other pastures, according to its capability, not only is the stock maintained on it all the year round in better condition, but such cases of epidemic death as I have mentioned as

having occurred amongst both lambs and ewes are of rare occurrence, and confined to seasons of unusual severity.

4737. *Letting of tups.*—Breeder of tups, besides disposing of them out and out at stated prices, by private bargain, appoint a day in autumn for letting their spare tups for the season, by auction, to the highest bidder, on the condition of being returned in good health and condition at the end of the tupping season. Times I have seen, when £50 have been obtained for the use of a Leicester tup for the season, and 60 ewes were the most he could serve; now £5 is nearer the mark, not because tups were so much better then, but because fine tups are now everywhere to be found in the country. This mode of disposing of extra stock is a good one, both for the breeder, who thereby realises an annual profit, and for the hirer, who thus finds a suitable opportunity for improving his flock.

4738. But the sheep thus offered to be let ought to be presented in their natural state—that is, washed and cared for in every possible way, as to food and shelter, but not trimmed, for the purpose of imposing qualities on them which they do not possess. Such a practice cannot be too much deprecated; and I am happy to say that most of our Scottish tup-breeders possess more integrity than to be lured into it. The English breeders, however, have fallen into the snare, and carry it to such an absurd pitch that a novice even, of the points of a sheep, could easily detect one of their trimmed sheep.

4739. It is necessary to explain to you that trimming, or dressing, consists in clipping away with the shears the points of the locks of wool over all the body, where they are considered to injure the appearance, or to affect the symmetry of the sheep; and the clipping is carried to such a degree that, on close-wooled sheep, such as the Southdown, the trimming is exercised over the entire body, so as to produce apparently fine points of symmetry in those parts of the sheep in which it is naturally deficient. This is nothing less than intentional fraud, to take in the ignorant and the unwary; for no judge can be deceived by it, and no one aware of the practice but must discover it at once. The eye of the inexperienced might be deceived by it at first, but the handling will dispel the illusion instantly. Such a practice is countenanced at all, I suppose, for no better reason than is the hefting of cows (2250) of their milk, because it is a custom. For the sake of fair dealing, it is hoped that this fraudulent practice will be forthwith abandoned.

4740. *The yellows.*—The yellows is a complaint to which ewes are subject in autumn. It is jaundice, exhibiting yellowness of the eye, the mucous membranes, and the urine. Bleeding, and purging with aloes and calomel, are the appropriate reme-

* A Lammermuir Farmer's *Treatise on Sheep*, p. 73-4.

† Little's *Practical Observations on Mountain Sheep*, p. 74-5.

dies. Fat draft-ewes which have fed some time upon aftermath are most liable to the disease. Inflammation of the liver is the cause, in which the pain of the affected part is very obscure, and the natural language of the sufferer not very expressive; nor is the symptomatic fever marked. Here a striking analogy is noted between the lower animals and man, inasmuch as there is generally a sympathetic pain in the right shoulder, so strongly marked, as often to be mistaken for the principal disorder, and treated accordingly. Whenever you observe, therefore, a lameness of the right leg of any fat sheep on foggage, you may suspect the existence of yellows, and examine the inside of the eyelid, and observe whether any yellowness exists there.

4741. *The rot*.—The rot is a serious disease, causing the death of numbers of a flock in a short period. Deficient food in summer, and a flush of rank wet grass in autumn, injure the health and constitution of sheep. In the wet and cold season of 1817, when sheep could not obtain a mouthful of good food in summer, and when the autumn arrived, accompanied with a flush of wet herbage, I knew a farmer on the Cheviot hills who lost 300 Cheviot ewes in the course of a few weeks by this disease.

4742. The early symptoms of rot are very obscure—a circumstance much to be lamented, as it is in the first stage alone that it admits of cure. “The animal is dull,” observes Mr Youatt; “lagging behind his companions, he does not feed so well as usual. If suspicion has been a little excited by this, the truth of the matter may easily be put to the test; for if the wool is parted, and especially about the brisket, the skin will have a pale yellow hue. The eye of the sheep beginning to sicken with the rot can never be mistaken: it is injected, but pale; the small veins at the corner of the eye are turgid, but they are filled with yellow serous fluid, and not with blood. The caruncle, or small glandular body at the corner of the eye, is also yellow. Farmers, very properly, pay great attention to this in their examination or purchase of sheep. If the caruncle is red, they have a proof, which never fails them, that the animal is healthy. If that body is white, they have no great objection or fear—it is generally so at grass; but if it is of a yellow colour, they immediately reject the sheep, although he may otherwise appear to be in the very best possible condition; for it is a proof that the liver is diseased, and the bile beginning to mingle with the blood. There is no loss of condition, but quite the contrary; for the sheep, in the early stage of rot, has a great propensity to fatten. Mr Bakewell was aware of this, for he used to overflow certain of his pastures, and when the water was run off, turn those of his sheep upon them which he wanted to prepare for the market. They speedily became rotted, and in the early stage of the rot they accumulated flesh and fat with wonderful rapidity. By this manœuvre

he used to gain 5 or 6 weeks on his neighbours.”

4743. I have already said, (947,) that when sheep have access to salt, they are never known to be affected with rot. I have little doubt, that had oil-cake been put within their power in such a wet and cold summer as 1817, they would have escaped the malady. Change of pasture from a wet to a dry situation may be the means of curing the rot, at an early stage of the disease. All land that has been irrigated in summer, and produces a rank growth of grass in autumn, should be avoided by sheep as much as a pestilence. Soft spongy soil, clayey, and never free of moisture, in its natural state, will affect sheep with rot when grazed upon it. Draining would render such land sound; and sheep-drains have made many pastures so, that were formerly subject to the complaint every year. When the rot is inevitable, sheep cannot be long kept on the same farm, but must be sold in the course of a few months; and the safest flock, in such circumstances, is a flying-stock, especially of ewes, for they are the most easily affected with rot. Lime has rendered land sound, which was subject to rot even after it had been drained. Sudden frost and thaw, alternately, in spring, produce rot, according to the old proverb—

Mony a frost, and mony a thaw,
Betaken mony a rotten yow.

4744. *Flukes*.—The liver of rotten sheep always contains the well-known animal the *flake*, so named from its striking resemblance to a flounder. Its nature has not yet been satisfactorily examined. It was named *Fasciola* by Linnæus, and *Distoma hepatica* by Rudolphi. Its intestinal ducts contain great numbers of grains of a pale red colour like sand, which are supposed to be its eggs; and as no difference of sex has been observed, it is believed to be a hermaphrodite. It is supposed that its eggs find their way to the grass, from which sheep receive them into their stomach, and thus are supposed to find their way into the liver. The eggs are found in the biliary ducts, in the intestinal canals, and even in the dung of healthy sheep; and they swarm in the dung of rotten ones. The ducts of a single liver have been found to contain more than a thousand, while the germs are quite innumerable.*

ON THE BATHING AND SMEARING OF SHEEP.

4745. Immediately after the tups are put to the ewes, arrangements are made for a part of the sheep stock to be prepared to be fattened on turnips (901,) and the preparation consists of bathing them with, or in a particular liquid. I have said that

* Youatt *On Sheep*, p. 445-62; *Quarterly Journal of Agriculture*, vol. v. p. 503, and vol. vi. p. 331-34; Parkinson *On Live Stock*, vol. i. p. 419.

sheep are affected by a troublesome insect—the ked or ked, or sheep-tick, fig. 308,—which increase so much in numbers, as the wool grows, as to be troublesome to the sheep in autumn; and were means not taken to remove them, the annoyance they would occasion would cause the sheep to rub themselves upon every object they could find, to a degree to tear their fleece, and deteriorate its value considerably.

4746. Another reason for bathing sheep is, that on experiencing so great a change of food, as from grass to turnips, cutaneous eruptions are apt to appear on the skin, even to the exhibition of the scab, (1071.) which deteriorates the fleece even more than the rubbing occasioned by the ked. In severe cases of scab, bathing is too mild an application, mercurial ointment being required. When lambs are rubbed with this ointment, inflammation will ensue if warm weather follows, though ewes stand the application much better. But I believe that spirit of tar by itself, or diluted with a little tobacco-liquor, is as efficacious and a much safer remedy.

4747. The liquid to be used as a bath, to be of service, should combine the properties of killing the ked with certainty, and of preventing eruptions on the skin, without injury to the staple of the wool; and both these ends are attained by the use of tobacco-liquor and spirit of tar, the former instantly destroying the ked, and the latter acting as a preservative to the skin, (1070.) The bath is necessary for all classes of sheep, to kill the keds; but the spirit of tar is specially useful for sheep bought to fatten on turnips, as travelled sheep are almost always affected with cutaneous eruptions, and particularly the Black-faced breed direct from the hills, after they have been on turnips for some time. As a matter of safety for a sound and clean flock, every sheep that is purchased, whether for feeding on turnip or increasing the flock, should be bathed immediately on its arrival on the farm, and before it mixes with the standing flock.

4748. The materials used in the bath are tobacco, spirit of tar, soft soap, and sulphur. The tobacco is best in the state of leaf, but I understand it is illegal for tobaccoists to sell it in that state. Taken

in the proportion of 1 lb. of tobacco to 20 sheep, it is put into a boiler with 1 quart of water to each 1 lb. of tobacco, and boiled gently for several hours. The tobacco is then wrung out, and the liquor taken out of the boiler; and the tobacco again returned into the empty boiler with half a quart of fresh water to each 1 lb. of the original weight, and boiled as long as any colouring matter is obtained from it, when it is wrung out and thrown away. The water boils in to 1 quart to the 1 lb. of the tobacco, and forms a decoction much stronger than an infusion.

4749. The soft soap is also used in the proportion of 1 lb. to 20 sheep, and it dissolves thoroughly in a sufficient quantity of warm water.

4750. The flour of sulphur is mixed with the soap in the proportion of 2 oz. to 20 sheep, with which it combines, and assists in preserving the colour of the wool from the staining of the tobacco-liquor.

4751. The tobacco-liquor is put into a tub, and the solution of soft soap is intimately mixed with it, the sulphur being put in last, and the whole mixed together.

4752. A tin flask easily holding one quart, and provided with a handle and long spout, small at the end, is used to pour the bath along the shedded wool of the sheep, and is represented by fig. 426.

Fig. 426.



A BATH-JUG.

4753. The spirit of tar is measured into a wine-glass from a greybeard, and poured into the flask of bath when about to be used, in the proportion of half a wine-glass to 1 quart, and the mixture stirred.

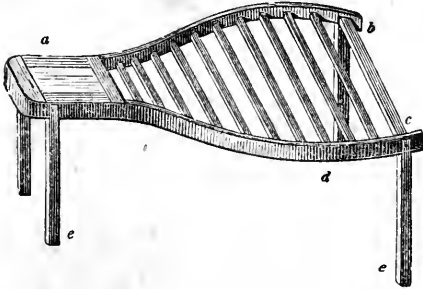
4754. Some people mix stale human urine with the bath to make it stronger,

but spirit of tar is more powerful than any ammoniacal gas.

4755. This is an effective bath, and inexpensive, the tobacco being 3s. 6d. per lb., a bottle of spirit of tar 6d., soft soap 5d., and sulphur 1s. per lb.—making the cost 5s. 6d. for 20, or 2½d. for each sheep.

4756. A useful implement in bathing sheep is the *bath-stool*, fig. 427, which

Fig. 427.



THE BATH-STOOL FOR SHEEP.

is made of the best ash. It consists of a seat *a*, for the shepherd to sit on while bathing the sheep, 1 foot square; a sparr'd part 3 feet long, has a frame and bars 30 inches wide in front from *b* to

Fig. 428.

c, its greatest width being across at *d*. The legs *e e*, are 18 inches high, attached by means of iron belts passing through their upper part and the frame of the stool, and secured with nut and screw.

4757. Dry weather should be chosen for bathing sheep, else the rain will wash away the newly applied bath.

4758. Coarse aprons should be worn by those who apply bath to sheep, it being a dirty process.

4759. The *bathing* is conducted in this way: The sheep being penned, one is caught and placed on the stool upon its belly, fig. 428, with its 4 legs hanging through the spars, and its head towards the shepherd, who sits astride on the seat. The staple of the wool is divided by the shepherd with the thumbs of both hands, beginning at the head and ending at the tail of the sheep; and when he has made one shed, an assistant, a field worker, pours the liquor from the flask, following the hands of the shepherd in their passage along the shed, which he keeps open from the tail to the head of the sheep. Fig. 428 shows the bathed sheep in a different pen from the un-



BATHING SHEEP.

bathed; the process of bathing as described; also the tub of tobacco-liquor, the quart measure, the greybeard containing the spirit of tar, and the wine-glass, all at hand.

4760. The sheds made are one along each side of the back-bone, one along the ribs on each side, one along each side of the belly, one along the nape of the neck, one along each side of the neck, and one along the counter. From these sheds the bath will spread over the whole body. The sheep is turned on its sides and its back, to obtain easy access to these several parts. When the sheep is lying on its back on the stool, its legs are not tied, so the assistant should be aware of receiving a kick from the hind feet on the face, or on the flask. Some liquor is put on the tail, head, scrotum, inside of the thighs, brisket, root of the neck, and top of the shoulder, because these are the parts most likely to be affected by scab, and are chiefly the seats of the nidi of insects. The shepherd and his assistant will bath 40 sheep in a day.

4761. Shortly after bathing, the keds will be seen adhering to the points of the wool, dead; and the fleeces of those sheep which have been much infested by this vermin will be speckled thick with their bodies. Sheep exhibit different effects by keds: those which recover from a lean to a better condition, on change of food, are most liable to be overrun with them, as some cattle are with lice when improving in condition on turnips, (1375.) On this account the ked may be expected to increase rapidly on sheep which have been some time on turnips, and hence the necessity of bathing sheep before putting them on turnips. Hoggs are most liable to their attack, because, perhaps, they get most rapidly into condition after being weaned, and because they bear the largest quantity of wool, (3942.)

4762. Hoggs (924) are bathed first, because, being put early on turnips—say the middle of October—they should be prepared before the ewes have returned from the tups.

4763. Ewes (925) should not be bathed till after being tupped, as the smell of the bath might counteract the effluvium of the season, and deceive the tup; and its effects upon the skin may even prevent the season coming in a regular course upon the ewe. Be the effects of bath what they may, the safe practice is not to bath flock-ewes till after being tupped;

on which account their bathing ought to be conducted with great care, as a twist or rack given to the body in catching, or in lifting them hastily off the ground, or in putting them recklessly upon the stool, may cause them to cast lamb; and, in case of such an accident, the sooner they are bathed after being tupped the better, the body then not being much under the influence of the fœtus. I am not aware that any case of ewes casting their lamb can be traced to this particular cause, but it is certain that injury to the body of any female in the period of gestation is liable to cause abortion; and there is no reason why injuries sustained at bathing should not produce that effect, as well as other occasions of injury. I dare say this particular source of injury to ewes has hitherto been overlooked both by farmers and shepherds.

4764. The tups (928) are bathed immediately before or after the ewes.

4765. A syringe has been recommended to be used to bath sheep, because it can be introduced amongst the wool without disturbing the adherence of the staples of the fleece, which shedding must do. No doubt, fleeces that have been shedded are more apt to be blown asunder by the wind, but only for a short time, after which they recover their coherence; and the uncertainty of knowing whether or not the whole body has been covered with the bath when applied by a syringe, more than counterbalances any advantage the fleece may derive from being kept entire. From the viscid nature of the bath, it is probable that a syringe will not eject the liquid at all times with the same effect. Such an instrument, in the hands of a rude operator, might tear off piles of wool unhidden to view, and even abrade the skin. I am disposed to believe that the manual operation of bathing will not easily be superseded by mechanical means.

4766. Instead of bathing sheep in this manner, which is one of long standing, it has been recommended to dip them bodily in tubs containing a bath-liquor. It is evident that any liquid, to be applied with certainty to the entire body of the sheep through its wool, must be as limpid as water; and, hence, all dipping compositions are dis-

solved in large quantities of water. A solution of corrosive sublimate will easily kill keds and harden the skin, and it is as limpid as water. I would not myself employ any composition that contains arsenic.

4767. Mr Bigg's sheep-dipping composition is sold at 9d. per lb., or in casks of 100 lb., sufficient to dip 500 sheep, for £3, 10s., which is rather more than 1½d. per sheep, and is thus a cheap application.

4768. Mr Wilson, chemist in Coldstream,

has contrived a dipping mixture, which kills vermin in sheep, and is said to improve the wool. The mixture is sold in packets: A packetful is dissolved in 2 imperial gallons of boiling water for 10 minutes, and poured into a large tub, containing 40 gallons of cold water. To this is added 4 lb. of soft soap, and the quantity will bath 50 hoggs. It will destroy all kinds of vermin in sheep in half-an-hour, but at what cost I have not heard.

4769. The apparatus in which the sheep are dipped is shown in operation by fig. 429, which consists of a wooden box for

Fig. 429.



WILSON'S SHEEP-DIPPING APPARATUS.

holding the bath, 3½ feet in length at top, and 2 feet 9 inches in width, and 3½ feet in length at bottom and 2 feet in width, giving the box a projection at the top over the bottom of 9 inches. This box will easily contain 100 gallons of the dipping liquid. Close to the right upper edge of the box is a drainer, 18 inches in width, consisting of spars of wood; and below it is an inclined plane the lower edge of which passes through the side of the box and conveys the dropped liquid into it again. The sheep are slid down an inclined plane into the pen. The pen is 8 feet in length, and 4½ feet in width, and capable of containing 10 or 12 hoggs at a time. A wicket at the end of it allows the sheep to go out. Its floor is boarded and grooved, to allow the liquid dripped from the sheep to run to an orifice, from which it is drawn off by a cock, and again put into the box,

for use. The apparatus may be conveyed to any given place on cast-iron wheels, and horse shafts might also be attached to it.

4770. Three men and a field-worker are required to use the apparatus, and they conduct the process in this manner:—Every sheep is held by two men, one on each side of the box. One man holds the head with the left hand, and the two fore-legs with the right; the other holds by the two hind-legs. They dip the entire body of the sheep, with the back undermost, with the exception of the head, in the bath for a few seconds. They then place the sheep upon the drainer where the field-worker squeezes the bath out of the wool with her hands, which returns immediately into the box by the inclined plane below the drainer. The sheep is then slid down on its side on the inclined plane into the pen

by the field-worker, where it remains for a time to drip the bath out of the wool. The third man catches and brings the sheep to the men at the box, to be bathed, from the enclosure in which they are confined by hurdles, fig. 40, or nets, fig. 44. In this way three men and a boy dipped 28 scores of hogs in 7 hours at Paston, Roxburghshire. This is quick work, and is a great saving of time and labour, as also of bath. Cheviot hogs have clipped 6 lb. or 7 lb. of wool after such dipping, and the process bids fair to supersede the bath of tobacco-liquor and spirit of tar described above.

4771. Wilson's dipping liquid being poisonous, care is necessary in putting away the last portion of it which is not used by the sheep, so as none of the pigs and the poultry may be poisoned by it. I am not acquainted with the composition of this dipping liquid, and therefore cannot recommend it on its own merits; but Mr Wilson's dipping apparatus is a most convenient one, and may be used with any dipping composition, and has evidently been constructed from practical experience, and does not impose a peculiar mode of dipping to suit its construction, as other apparatus does which I have seen, on which account I have noticed it in preference to other forms.

4772. Wherever sheep are kept as a standing flock over the winter in the low country, bathing is requisite; and when sheep are bought in to be put on turnips in winter, as is most frequently done on farms in the neighbourhood of towns, bathing must there be also practised. On *carse* farms, where no sheep are kept, the process is unknown.

4773. Hill flocks are prepared for the winter by putting substances upon the skin, not merely for the purpose of killing vermin, but of protecting their bodies against the effects of severe cold and rain. For this latter purpose a thin liquid will not suffice; it must have such a consistence as to withstand melting by the natural temperature of the body, and washing away by the most drenching rains. The substances which possess those properties in a high degree are tar and butter. The tar itself would effect both purposes, as its pitchy tenacity prevents its melting at a low temperature, and rain has little effect upon it; but the butter is added to neutralise the caustic effect of the tar upon the skin, and at the same time to encourage the growth of the wool. When the skin of a sheep is covered with such substances, it is said to be *smearcd*.

4774. Now the practice of smearing is unsupported either by theory or common sense; for why should plastering over the skin with an adhesive substance protect the body from cold, while its natural clothing of wool is incapable of affording it the warmth required? Does not the plugging up of the pores of an animal's skin injure its health? Why should an external application to the skin promote the growth of wool, which derives its sole support from the body of the animal? No doubt, *very lean* sheep may be injured from the united effects of rain and cold; but sheep in such condition are not sufficiently covered with wool to protect their lean bodies from the elements. Common sense suggests that a thick covering of flesh and fat on the bodies will withstand cold and throw off rain better than tar, while the natural functions of the skin will be preserved; that a thick covering of flesh and fat will promote the growth of wool better than butter; and that a thick covering of wool, flesh, and fat, will ward off cold and rain better than any substitute that man can apply. Food and shelter, then, are alone wanting to free hill-flocks from the filthy process of smearing; and it is satisfactory to observe hill-farmers arriving at the conviction of the insufficiency of smearing, as an equivalent for food and shelter. But still mountain sheep, like all others, ought to be relieved from the annoyance of vermin.

4775. But another circumstance, extrinsic of the farm, tends to force the same conviction on hill-farmers, in the desire of the woollen manufacturers to obtain wool free of extraneous matter, because it suits their purpose better in causing less waste in the manufacture, than the wool ordinarily supplied from hill-farms. The waste in scouring and dyeing wool that has been smeared is one-half; and when it is smeared with tar and butter, it is five-eighths of its bulk. Hence the low price always offered by dealers for smeared wool. It might be impolitic to relinquish smearing entirely, until other means have been contrived as a substitute. The sudden abandonment of smearing might endanger the health and constitution of hill-sheep.*

4776. There are many varieties of salves in use, and trials of new ones every year evince the dissatisfaction of hill-farmers in them, because they have failed, and I have no hesitation in affirming they will all fail, as substitutes for flesh and fat, to raise wool worth the manufacturer's consideration. From the remarks of Mr Boyd of Innerleithen, on the efficacy of a new salve approved of by several hill-farmers, it would appear that its chief quality consists in destroying vermin.† That vermin ought to be destroyed at all hazards, is certain, from the circumstance that when sheep of every sort, and especially those on the hills, are annoyed by them, they will not settle to their food, but will rub against every object they can find—a stone, tree-stump, earthy banks, or roots of heather—and tear off their wool, and expose themselves

* Prize Essays of the Highland and Agricultural Society, vol. xiv. p. 652-62.

† *Ibid.*, vol. xiv. p. 62-3.

more and more to the effects of the weather. They will also run about impatiently, and become heated, and then become chilled by the first blast they afterwards may encounter. Rain makes vermin more active, and the annoyance created by their increased activity is almost fit to render sheep frantic.

4777. The three following salves are recommended, and considered improvements, by the farmers of Peebles and Selkirk shires, on those in common use. The first, at the price of grease butter in 1850, from 3s. 6d. to 3s. per cwt., is as follows :—

	s. d.
$\frac{3}{4}$ lb. crude white arsenic, at 5d. per lb.	0 3 $\frac{3}{4}$
28 lb. butter at 3 $\frac{3}{4}$ per lb.	8 9
5 lb. black-soap, at 3d. per lb.	1 3
$\frac{1}{2}$ gallon turpentine, at 3s. per gallon,	1 6
	<hr/>
	11 9 $\frac{3}{4}$

This compound, with 60 quarts of water, forms a salve for 100 sheep, and costs something less than 1 $\frac{1}{4}$ d. a sheep. The water being heated, serves to keep the salve in a liquid state during the time it is applied to the sheep; and too much attention cannot be bestowed on stirring the mixture, as the arsenic is apt to fall to the bottom; and on spreading the salve evenly on the skin. This salve was proposed by Mr Ballantyne, Holylee, in Peeblesshire, and differs from that adopted by the farmers in 1833 by the addition of the turpentine, which, having resinous properties, is said to keep the wool closer over the sheep.

4778. Another of the salves consists of the following ingredients :—

	s. d.
1 lb. arsenic, at 5d. per lb.,	0 5
12 lb. butter, at 3 $\frac{3}{4}$ per lb.,	3 9
3 lb. black soap, at 3d. per lb.,	0 9
2 bottles of best fish-oil, at 3s. per gallon,	1 0
	<hr/>
	5 11

These, mixed with 60 quarts of water, will bath 100 sheep, at a cost of rather more than $\frac{1}{4}$ d. a sheep. This salve is made in this manner :—“To 12 quarts of water add 3 lb of black soap; and when it comes to the boil add 1 lb. of arsenic, and let the whole boil together for 10 minutes. Then add 12 lb. of butter, and 2 bottles of fish-oil, and boil the whole 5 minutes longer, stirring the mixture all the time. Then pour in as much water as to make 60 quarts. When used, a little is heated at a time in a pot, as it is too thick for use when cold. It should be poured on the sheep out of a tin teapot, and a long handled tin-ladle should be used for stirring up the mixture in the pot, and pouring it into the teapot. The last quantity of the mixture should have a little water added to it, as it will become too strong by reason of the deposition of the arsenic to the bottom.”

4779. This salve, when liquid, is put on the sheep in this manner :—“The sheep should be laid on the smearing-stool, fig. 427, in such a

position as when the first shed is opened from the ear along the upper part of the ribs, and about 5 or 6 inches from the back, to a little below the loin bone, the mixture, which should be poured in double quantity, may run towards the middle of the back, and it will serve to saturate all the wool left unopened towards the back. Other 3 long sheds on the side, 2 on the edge of the belly, 2 on the shoulder and neck, with a little salve on the breast, between the thighs, and the front of the hip, will suffice for one side. Then turn up the other side of the sheep, and lay it exactly in the same position as at first, that is, with the back lowermost, to facilitate the liquid running towards it, which it will readily do. Then pour on this side as was done on the other, always taking care not to carry the sheds towards the tail farther than in a line drawn from the top of the loin to the middle of the thigh. The descent from that line being towards the tail, the liquid will find its way to that part. The principal object to be attended to in the above process is to keep the exposed parts of the animal as free of sheds in the wool as possible, which will thus be done, and yet the whole of the wool be sufficiently saturated with the mixture.”* The hinder part of a sheep bears the coarsest wool, and as the sheep always exposes that part to the storm, and as the top of the back is most exposed to falls of rain, these particular parts being kept free of sheds, the wool will there scarcely be thrown open by the wind. When using this liquid, the shepherd should protect his legs with a leathern apron, and a man and a boy will pour 70 sheep in a day; but when everything is conveniently placed, and no delay occurs, they will pour 80 in that time. It should be remarked, however, that all animal oils give a brown tinge, and moss-water, when employed to wash sheep, gives a blue tinge to wool—both of which colours have to be got rid of in manufacture, though neither may injure the texture of the wool.

4780. The third of the salves was proposed by Mr Joseph Stewart, Leslie, in Fife, a practical shepherd. A lengthened experience in the smearing of sheep has convinced him that the greater number of the substances usually employed for that purpose are more or less injurious, both to the sheep and their wool. Such he considers to be the effects of tar, turpentine, tobacco-juice, and arsenic; and as to arsenic in particular, he regards it so deleterious as to be inadmissible into any sheep salve—an opinion with which I coincide. He has known sheep, after being smeared with a salve, of which arsenic formed a part, remain in a dull and unthriving state all winter; and when the use of the salve was persevered in for 3 consecutive years, the sheep lost their teeth. To avoid such an evil, he had recourse to simpler substances, and found that a mixture of oil and tallow, in equal proportions, answers the purpose well. These may be used alone, or in admixture with a small quantity of tar; but he conceives that the oil and tallow of themselves form the best salve for sheep that has hitherto been tried, and

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 67-8.

is convinced, that if the sheep-farmers of Scotland would use that salve alone, they would find their advantage in obtaining a third more money for the wool on account of its superior quality, improved partly by the better condition of the sheep.

4781. In applying tar-salve to sheep, when thick, it may be taken up on the fore and middle fingers of the right hand, and spread along the shed, and worked amongst the wool; and when thin, the palm of the hand in a hollow shape is used for lifting and pouring it on, and working it in. The stool, fig. 427, is employed for laying the sheep on, though this convenient implement is not used so much as it ought. American tar in 1850 was from 14s. to 15s. 6d. per barrel.

4782. Besides a covering from the weather, afforded by stells, bratting has been adopted as a substitute for smearing in winter; and the method of using a brat, and the figure of a brated sheep, and the utility of brating, will be found explained in (1038) and (1040,) and fig. 61.

4783. The effects of arsenic applied externally to the skins of animals, is worthy of the consideration of those who employ arsenical solutions for bathing sheep. "Instances of arsenic destroying life when applied externally," observes Dr Taylor, "are by no means unfrequent. Two cases of its operating fatally in children, when applied to the skin of the head for *tinea capitis*, will be found in the *Annales d'Hygiène*, 1830, ii. 437. In both, the mucous membrane of the stomach was found inflamed, and in one extensively. A trial has recently taken place, (*Rep. v. Port*, Chester Winter Assizes, 1844), in which a man, pretending to cure cancer, was charged with the death of a female, by the application of an arsenical plaster, as it was supposed, to the breast. The woman died in a fortnight. No satisfactory evidence was obtained of the symptoms during life, except that there had been vomiting; and the accused had taken care to remove the plasters as soon as serious symptoms had begun to appear; hence there was no direct chemical evidence of the nature of the substance actually employed. This case, however, shows the great utility of the discovery of the *absorption of arsenic into the body*. Dr Brett, of Liverpool, was able to detect the absorbed arsenic in the substance of the stomach, liver, and spleen: the quantity detected was less than a quarter of a grain. The œsophagus, stomach, and intestines were found extensively inflamed. . . . In January 1845, a man in London died apparently from the effects of arsenic *absorbed through the skin of the arm*. He was engaged in the manufacture of candles, to which arsenic was added in large proportion, and it was supposed that an *abrasion of the skin* had facilitated the absorption of the poison. The medical opinion given at the inquest, was decidedly that the deceased had died from the effects of arsenic *thus introduced into the system*. M. Flaudin states, that on one occasion he had to examine the viscera of a woman who had been killed by the application

of an arsenical powder for the cure of a scirrhus breast. The arsenic (absorbed) was discerned in various parts of the body, but especially in the liver, which contained as much as is usually found when the poison has been swallowed: the quantity was greater than that found in all the other organs together. This case presents many points of interest. The poison did not begin to produce its well-marked effects until after the lapse of about *ten hours*. Death took place in about six days, and the urine was suppressed throughout. The mucous membrane of the stomach and intestines was in its natural state: in the duodenum it was slightly swollen or thickened."

4784. "Several cases are reported, in which arsenic has acted as a poison through the *unbroken skin*. Some of these are of old standing, and do not appear to have been accurately observed. *If the arsenic be in solution, it may become speedily absorbed*; but when in powder, absorption would take place much more slowly. It is well known, that comparatively insoluble substances may be introduced into the system by the endermic method, and arsenic does not appear to present any exception to this mode of operation. The thin skin of the human subject appears to absorb the poison more readily than the hard thick skin of animals; but M. Flaudin found that dogs were speedily killed when arsenical ointments were rubbed upon the skin of the abdomen, or on the inside of the thighs. All the symptoms of arsenical poisoning, although not appearing for two or three days, have been witnessed in the human subject in those cases in which powdered arsenic has been used as a depilatory."

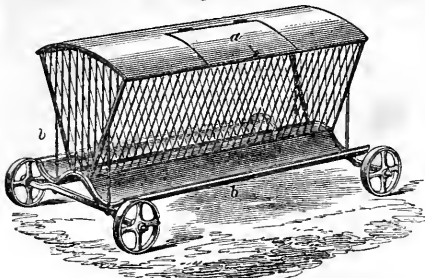
4785. It thus appears from the observations of Dr Taylor, that arsenic, whether in solution or in powder, may be absorbed by ulcerated surfaces, such as scab; by abraded skin, such as occasioned by rubbing from the irritation of keds, or the attack of maggots; and even by unbroken skin. The safest course, to avoid such risks, is to render arsenic unknown in all farm operations.

4786. Even the use of corrosive sublimate is not free of danger, for although Dr Taylor observes, that it is not likely that any question will ever arise respecting a poisonous impregnation of the flesh, from the use of a lotion for the purpose of destroying the fly in sheep, yet he refers to a case, reported by Mr Annan, of two sheep which died from the effects of the external application of corrosive sublimate—a poison, he remarks, which is most easily absorbed. (*Med. Times*, July 25, 1846, 331.) "The flesh of these animals might have proved dangerous if it had been eaten."*

4787. As this is the last opportunity I shall have of speaking of sheep before they are put on turnips in winter, (901.) I would recommend a sheep-rack which was exhibited by Mr James Kirkwood of Tranent, the inventor and maker of many ingenious and useful implements, and

* Taylor *On Poisons*, p. 323-5, and 165.

which obtained the first premium at the Highland and Agricultural show at Glasgow, on the 1st of August 1850. Fig. 430 gives a view in perspective.



KIRKWOOD'S WIRE SHEEP-FODDER RACK.

tive of this elegant, strong, and useful fodder-rack for sheep, to be used either on grass, or on turnips in winter. It consists of wire-work, the body being 6 feet long, 2 feet 9 inches wide at top, 8 inches wide at bottom, and 2 feet $3\frac{1}{2}$ inches in depth. The cover consists of sheet-iron, curved to throw off the rain, and the fodder is put into the rack by throwing open the hatch *a*, in the cover. The refuse from the fodder, such as hay, falls upon the troughs *b b*, made also of sheet-iron, and may be eaten by the sheep, and at all events saved from being trodden into the ground. The troughs are provided with a hole at each end to allow the rain to drain off, and might be used in dry weather for holding salt, oil-cake, or corn for the day. The machine is mounted on axles and wheels, and may be moved to any desired spot. The iron supports and axles being malleable, the implement is rather costly—being L.4, 4s.—but its strength and durability must be great; and perhaps it may be made for less money when it comes into general use, which it certainly deserves to be.

ON LIFTING POTATOES.

4788. The harvest-work of a farm cannot be said to be completed until the potato crop has been taken out of the ground, and secured against the winter's frost. By October the potatoes may be expected to be ready for lifting. Potatoes indicate their fitness for being lifted by the decay of the haulms; for, as long as these are green, you may conclude the tubers have not arrived at maturity. In an early season potatoes ripen before October; and although the weather should then continue fine, the best plan is to let them remain in the ground until all the grain crops are harvested; but in ordinary seasons the corn is cut down and carried before the potatoes are ready for lifting.

Immediately after the fields are cleared of corn, the potatoes should be taken up and secured, to allow the land to be ploughed up for wheat.

4789. Two modes are followed in lifting potatoes—one with the plough, and the other with the hand by means of the potato-graip. The plough affords the most expeditious means, though the ground is most thoroughly cleared of the potatoes by means of the graip.

4790. In employing the *plough* to take up potatoes, the common one, with two horses, answers well; but as the potatoes run the hazard of being cut by the coulter, it should be taken out, the sock lifting up the potatoes from the bottom of the drill, and the mould-board turning them out upon the surface. The ploughman should take in a feering, fig. 19, of as many drills as covers about two ridges; and in going up the outside drill he splits it, and in returning by the outside drill on the other side of the feering, splits it also, throwing the potatoes out of the ground, in both cases, to his right hand—but no faster than a band of gatherers, of field-workers, can gather them in baskets. Feering after feering is thus made, and the potatoes gathered.

4791. The gatherers, chiefly field-workers, but assisted by hired women, labourers, or boys and girls, when their numbers are insufficient for the work, follow the plough, each provided with a round basket with a handle, fig. 235; and if these are not sufficient in number, two gatherers fill a basket between them, into which they gather the potatoes as fast as possible; and as soon as any basket is filled, it is taken and emptied into the cart, loosened in a convenient part of the field, to receive them. In light and clean soil, the potatoes easily part from it, and are agreeably and quickly picked up; but in heavy soil, and in all soils in foul condition, the plough-farrow is apt to turn over entire, and the potatoes to be enclosed within it—in which case a stout field-worker should precede the gatherers, and follow the plough with a small common graip, fig. 82, and shake the furrow loose, and free the potatoes from the soil and the haulms for the gatherers. Every the smallest potato

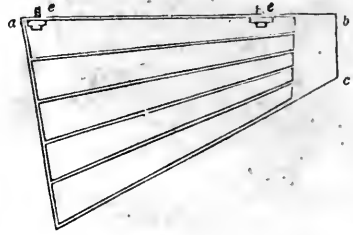
should be gathered, not only for the sake of economy, but of removing a weed from the succeeding crop. The gathering should not be continued so late in the evening as that the potatoes cannot be easily seen, nor should it be persevered in in rain.

4792. After the field has been gathered of its potatoes in this manner, the harrows are passed over the ground a double time, to bring up the concealed potatoes to the surface, and to shake the haulms free of the soil. The potatoes thus after-gathered are usually reserved for the pigs and the poultry.

4793. Whenever the field is cleared of the crop, the haulms are gathered by the field-workers and carried to the compost stance, to be converted into manure, (2042;) and these are the only direct return which the potato crop makes to the soil, except the part which happens to be consumed by the cattle on the farm.

4794. A simple instrument, fig. 431, which may be substituted in the plough for the mould-board, for turning the potatoes out of the ground, was contrived by

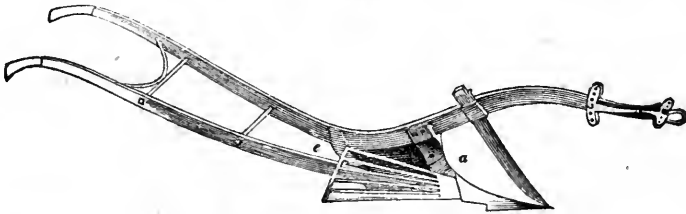
Fig. 431.



THE POTATO RAISER OR BRANDER.

Mr Lawson of Elgin. It consists of 6 malleable iron bars, the outer ones $\frac{5}{8}$ of an inch square, the inner ones half an inch in diameter, joined together in the form of a brander, 26 inches long from *a* to *b*; 5 inches in breadth from *b* to *c*, at the fore part, where is a plate of iron; 27 inches in length from *c* to *d*; and 18 inches in

Fig. 432.



THE POTATO-RAISER ATTACHED TO A PLOUGH.

breadth from *d* to *a*. The openings between the rods will thus be rather more than 3 inches at the widest end of the brander, between *a* and *d*. This brander is attached to the right side of the head and stilt of a plough, in lieu of the mould-board, by the screws *e e*, the fore end *b c* being placed close behind the sock, as seen at *a*, fig. 432, which shows the plough mounted with the brander, having its upper angle *e*, 8 inches, and the plane of its face so bent down as to have the lower angle *d* only 4 inches above the sole of the plough. The mode of operation of the brander is, that while the earth partly passes through it, and is partly pushed aside by it, the potatoes are left exposed upon the surface of the ground on the right hand of the ploughman.

4795. The gatherers follow this plough with baskets, the same as the common plough—but some of them must throw the haulms upon the gathered ground which lies to the right hand of the drill they are gathering the potatoes from; and the reason why this must be done is, that, as soon as the potatoes which lie on the surface are gathered, the plough returns, and proceeds through the remaining part of the drill in which the potatoes lie, still turning the earth and potatoes to the right hand. This second operation raises to the surface any stray potatoes which the first may not have turned up, and which the women gather. This plough pulverises the soil in an extraordinary degree, and scarcely leaves a single potato in it. Mr Lawson observes, "I have never before been able to clear my fields of potatoes so

effectually as by this implement, or at nearly so small an expense." *

4796. When potatoes are taken up by manual labour, it is done

Fig. 433.



THE POTATO-GRAIP.

by means of the *potato-graip*, fig. 433, the prongs of which are flattened. To use this graip efficiently being rather severe work, men are employed to lift the potatoes with it, one man taking a drill close beside that of his fellow-workmen, while 2 gatherers, women, boys, or girls, to every man, pick up the potatoes as he turns them out of the ground, and put them into the baskets.

4797. In using this graip, it is inserted into the side, not upon the top of the drill, and below, not above the potatoes, with a push of the foot; and the earth thus undermined is turned over into the hollow of the drill, exposing the potatoes to view upon the inverted spit, from whence they are gathered off. The men then pass the prongs of the graip here and there through the soil, to exhume and expose to view every potato lurking beneath it.

4798. In this manner, 1 man and 2 women will take up, of a good crop of 80 bolls of 16 stones or 2 cwt. per acre, 20 bolls a-day, which will cost 16s. per acre, or rather more than 2½d. per boll, at the following wages:—1 man 2s., and 2 women at 1s. each per day, without food. The boll of 32 stones or 4 cwt. will cost, near towns, 6d. for lifting.

4799. Potato-graips cost 2s. 3d., and when handled 3s. each.

4800. When a farmer lifts the potatoes on his own account to be disposed of afterwards, they are put into the cart without measurement or selection, and carried directly to the pits.

4801. When lifted for a purchaser who

has bought the crop in the ground, the potatoes are measured, fig. 168, or weighed from the basket on the spot into sacks, and delivered out of the sacks.

4802. When the farmer lifts them to send to the London market direct from the field, the potatoes are first separated by wire riddles, through which those under the stipulated size, 1½ inch in diameter, pass, and the others are measured into sacks and carried directly to the ship's side. The potatoes which fell through the riddle are taken home by the farmer.

4803. The potato-riddle is made of wire, in meshes of from 1¾ to 1½ inch square, and when rimmed with oak, costs 2s. 6d. each, fig. 160.

4804. Potatoes are most commonly made up by measure in Scotland into what are termed *bolls*. The boll is a given weight, which varies with the custom of the district. They ought in all cases to be sold by weight.

4805. The boll weighs 2 cwt. or 16 stones of 14 lb. to the stone, in some parts of the country, and double that weight in other parts; while in some places it is as much as 40 stones. The lightest weight is called the *single*, and the heavier one the *double boll*. It is surprising how difficult it is to introduce a uniform system of weights and measures into a country.

4806. The produce of potatoes varies amazingly, according as the season is very dry or wet. Even before the existence of the failure, it varied from 30 single bolls or 60 cwt. = 3 tons, in a very dry season; to 120 bolls or 240 cwt. = 12 tons to the acre in a moist, growing one. The disease has caused a still greater variety in the quantity.

4807. The price does not vary with the quantity, a scanty crop seldom exceeding 6s. the single boll of 2 cwt., and the plentiful one not under 4s. Since the disease the price has risen to 30s. the small boll, which I have paid for good seed.

4808. Taking a medium potato crop at 60 small bolls of 2 cwt. each, or 6 tons,

* *Quarterly Journal of Agriculture*, vol. viii. p. 551-2.

and a medium price of 5s. the boll, it yields £15 an acre; and allowing 40s. an acre as the cost of all the labour connected with the disposal of the crop, the return is still £13 an acre—a large sum; but it ought to be remembered that potatoes, when entirely disposed of, leave no manure on the farm, while they require more than an ordinary quantity to raise a crop; and they also incur considerable trouble in the delivery, and, being a perishable commodity, cannot be preserved beyond a given time. Since the occurrence of the disease, no particular sum can be relied on from this crop; and in consequence its culture has become an uncertain speculation. Henceforward the returns from this crop must be left out of calculation.

4809. Where farm-servants have potato ground given them as part of their wages, their crop is taken up with the rest of the field, and the cost of taking it up falls upon the master. Where they receive a stipulated quantity of potatoes, instead of a given space of ground, it is delivered to them as taken up from the field. The quantity stipulated for is 7 or 8 bolls, of 32 stones each, or from 28 to 32 cwt. The quantity should be measured or weighed, but the body of the cart is usually made the instrument of measurement; and I believe they prefer taking their chance in this, well knowing the quantity is never under the just amount. Of the two modes of paying servants, in prolific seasons they are well supplied when the ground is planted for them; but in bad seasons they suffer privation, which they bear patiently, knowing that the deficiency arises from no circumstance over which their master has a control; and those who receive a stated allowance every year, suffer in a bad year by deterioration of quality. The former class of servants have always a direct interest in the quantity, and both have so in the quality of the crop. Since the potato failure, instances have occurred when it was out of the power of the master to pay the stipulated quantity to the servants, and a compromise has been substituted of £3 in money, or of 3 bolls = 24 stones of meal, of 14 lb. to the stone. Those who had the ground planted had no claim on their master on account of the failure of the crop; but some allowance, I believe, was made in most cases.

4810. I may hint, on lifting the crop, that a few potatoes prove an acceptable gift to the lone cot-woman who works in your fields, or whose daughter fulfils the useful office of field-worker.

4811. Those who desire to plant unripe potatoes as seed, should take up the quantity required before the haulm indicates a ripened state in the general crop. Perhaps the small potatoes of the crop would answer the purpose, as they are the latest efforts of the potato-bearing fibres; not small potatoes as such, since the entire crop may consist of small potatoes, and be fully ripe, and as unfit for seed as the fully ripened largest ones.

4812. The proportions of the component parts of the potato will be found in (1255) and (1256.) Its nutrient properties are mentioned in (1254), (1259), and (1260.) Its inorganic constituents are given in (1257) and (1258.) The composition of the ash of the potato leaves and stems is stated in (4159) and (4160.)

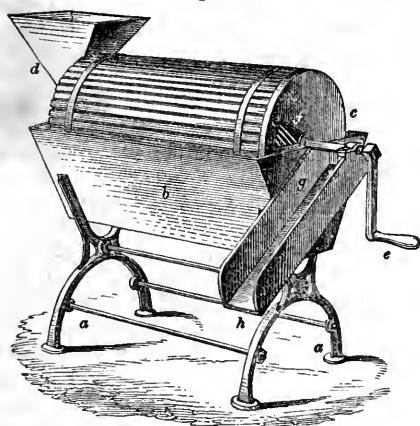
4813. Potato-starch may be converted into a substance having the properties of tapioca. An acquaintance of mine in Forfarshire, the late Mr James Scott, Beauchamp, raised large quantities of potatoes every year before the appearance of the disease amongst them; and instead of disposing of them in the bulk, converted them into *tapioca*. For this purpose he erected machinery in connexion with his thrashing-mill steam-engine, to grate the potatoes into pulp, and to wash the starch out of the pulp. The pulp was afterwards dried in tin vessels in an oven. The *tapioca* thus obtained was put up in paper parcels of a pound weight, and sold to a house in Glasgow at, I believe, 8d. per lb. The delivery of the *tapioca* at the shipping port of Arbroath was a great saving of cartage, compared to what would have been the delivery of the potatoes in bulk. The refuse of the manufacture, consisting chiefly of the fibrous matter of the potato, was retained to give to pigs (1593) and farm-horses.

4814. The fecula of the potato presents very varied forms, and no other known kind acquires so large a size, observes M. Raspail. "When first obtained from the organs of the plant, it exhibits concentric wrinkles on its surface, which disappear when it dries. The largest grains are about '0049 of an inch in size. The most common size is from '004 to '0015. They are oval, contracted in the middle, like the cocoon of the silk-worm; gibbous, obscurely triangular, or rounded, and the smallest are spherical. The potato is the only plant whose fecula is used for culinary purposes, as it can be obtained at a cheaper rate than any other. To extract it, the tubercles are washed and scrubbed, after which they are rasped under a stream of water, which carries the raspings to a sieve, through whose

meshes the fecula alone passes into a vessel placed below. When the operation is finished, the water is poured off, and the fecula is repeatedly washed until the water carries off no soluble matter; after which it is dried in the sun or in a stove. This fecula then has the appearance of an impalpable crystalline powder, having a white colour with a bluish tinge. The grains are less altered in this than in any other variety of fecula.*

4815. Fig. 434 gives a view in perspective of

Fig. 434.



THE SELF-DELIVERING POTATO-WASHER.

an excellent potato-washer, which was exhibited at the Highland and Agricultural Society's Show at Edinburgh in 1848, by Mr Richard Robinson of Belfast. It consists of two cast-iron frames *a a* connected together by means of three round malleable iron rods. In the forks of these frames is inserted a wooden box or cistern *b*, wider at the top than at the bottom, to contain the water to wash the potatoes. The cylinder *c*, having a larger diameter at *c* than at the other end, is spars with fillets of wood fastened on with iron hoops, at such distances as to prevent potatoes slipping through between them. The cylinder *c* is hung on the box *b* by means of an iron axle, which passes through both ends of the cylinder, and turns upon plumber-blocks, the nearest end being extended as far as to allow the trough *g* to be suspended between the box and the winch-handle *e*, which is supported on its extremity. The hopper *d* receives the potatoes, which pass over a grating in its inclined bottom, through which any earth or sand falls to the ground.

4816. The washer is used in this manner:—Water is poured into the box *b* until it is nearly full. The potatoes are then put into the hopper *d* by means of a shovel or basket, and after passing over the grating find their way into the cylinder. On turning the winch-handle *e*, the

cylinder revolves and takes the potatoes with it through the water; and as the potatoes find their way along its inclined bottom in the water, they are taken up by a twisted sparrd inclined plane, which carries them to the opening *f* in its boarded end, *c*, to a level of the edge of the box, over which they run down the inclined plane of the slide *g*, which conveys them as far as *h*, where a tub, barrow, or basket, is placed on the ground to receive them in a thoroughly washed and clean state.

4817. The peculiar advantage of this machine is, that in turning the winch-handle *e* to the right, and keeping the hopper *d* supplied with dirty potatoes, it washes them and throws them out clean in a continuous stream to the bottom of the slide *h*. On turning the winch-handle *e* to the left, the potatoes are retained within the cylinder, until the washing is effected as completely as you desire; and then, by turning it to the right, you get quit of the potatoes instantly. In machines heretofore in use, the washing process is stopped to fill and empty the cylinder, which must be raised out of the cistern for those purposes, and lowered again into it, by a tedious and laborious process. The price of this machine is L.3, 10s.

4818. Potatoes are generally given to cattle in an unwashed state; and when they are taken up in dry weather from dry soil, but little earth adheres to them; but in rainy weather they cannot fail to take away much of the soil, most of which the cattle are obliged to receive. With such a washer as this, the quota of potatoes given to the cattle may be washed every day in a few minutes; and it ought to be washed without fail.

4819. "When potatoes are boiled, they lose from 1 to 1½ per cent of their weight. The juice which may be separated from them is sweet-tasted. The meal is insoluble even in boiling water, though potato-starch forms a transparent solution with hot water. Thus it appears that, by boiling, the albumen, fibrous matter, and starch combine together, and form an insoluble compound." Simple as the process seems, it is not every cook who can boil a potato well.

4820. "Dr Peschier of Geneva has detected the presence of mucous sugar and of gum in the potato. This explains why it is capable of undergoing the vinous fermentation. The acids contained in potatoes in the natural state were ascertained by Einhoff to be a mixture of the tartaric and phosphoric acids."

4821. "It is well known that a spirit can be extracted from potatoes. From this spirit Messrs Bertillon and Guietand extracted a volatile oil, which M. Pelletan found to be a colourless limpid liquid, having a strong smell, hot acrid taste, very soluble in alcohol, and obviously containing much alcohol." †

* Raspail's *Organic Chemistry*, p. 111.

† Thomson's *Organic Chemistry—Vegetables*, p. 481 and 842.

4822. I remember seeing potatoes that had lain neglected for some time in a damp corner of a meal mill, which seemed like lumps of brown semi-transparent resin, and as light in the hand, the skin being translucent though as rough as in the natural state. On boiling a few, I found they regained the ordinary mealy character of a good potato, and tasted as well. This incident occurred before the appearance of the failure.

ON STORING POTATOES.

4823. The object of *storing* potatoes is to place them beyond the reach of frost. No difficulty is found in doing so in the early part of winter, when the temperature is merely low, and not frosty, and vegetation dormant. Potatoes may therefore be kept in almost any situation in the early part of winter; but if damp is allowed to reach them for a length of time, they will rot; and if the air finds access to them in winter, the frost will not only reach them, but vegetation will be awakened in them in early spring. To place them effectually beyond the influence of the elements, they should be stored in a dry place, and closely covered up; and no mode affords both requisites so completely as ordinary dry soil.

4824. Fig. 435 exhibits the two ordinary forms of pits, one conical, the other prismatic. The conical form is employed

for pitting small quantities of potatoes, and is well adapted for small farms and cottars; the prismatic is used for storing large quantities. For both sorts of pits, a situation sheltered from the north wind should be selected; and the ground as dry of itself as to absorb the rain as fast as it falls, or as much inclined as to allow surface water to run away quickly. The site should be conveniently chosen for opening the pits and admitting carts to them, at the corner or side of a field, so as not to interfere with its work in winter, and as near the steading as possible.

4825. A *conical* pit of potatoes is formed in this manner:—If the soil is of ordinary tenacity, and not very dry, let a small spot of its surface be smoothed with the spade. Upon this spot, let the potatoes, as they are taken out of the cart, be built by hand in a conical heap, not exceeding 2 feet in height; and the diameter which a cone of that height will occupy, so as not to impose much trouble in piling up the potatoes, will be about 6 feet—that is, $1\frac{1}{2}$ foot in breadth to 1 foot in height. The potatoes are then covered with a thick thatching of dry clean straw—not drawn, as is too commonly the case, but broken. Earth is then dug with a spade from the ground in the form of a trench around the pit, the inner edge *a*, fig. 435, of the trench being cut as far from

Fig. 435.



THE CONICAL AND PRISMATIC FORMS OF POTATO-PITS.

the pile of potatoes as will be the thickness of both the covering and of the earth to be put upon it, which may be about 1 foot. The first spadeful is laid upon the lower edge of the straw, and round the heap of potatoes in a circle; the earth being chopped fine and beaten down with the spade, to render it as impervious to cold as possible; and the drier it is, the less effect will frost

have upon it, and penetrate into it the less distance. Thus spadeful after spadeful of the earth is taken from the trench, and heaped on the straw above the potatoes, until the entire cone *a b c* is formed, which is then beaten smooth and round with the back of the spade. The sharp apex of the cone at *b* will be about 3 feet 3 inches in height, and the diameter of

the cone from *c* to *a* about 8 feet. The trench round by *a c* should be cleared of earth; and an open cut made from its lowest side, to allow any water to run freely away.

4826. When the soil is naturally dry, the site of the pit may be dug out of the solid ground a spade depth, for storing the potatoes into what is then really a pit, and the height of the heap above the surface of the soil will be proportionally less; but unless the soil is as dry as sand or gravel, the potatoes should be piled upon the natural surface of the ground.

4827. The *prismatic* or *long* pit, *d e f g h*, fig. 435, is formed exactly in the same manner, with the exception that the potatoes are piled in a straight line along its sides and ends *d h* and *d e*, instead of round, as in a conical heap. The height of the pile of potatoes should not exceed $2\frac{1}{2}$ feet, and its breadth will spread out to about $7\frac{1}{2}$ feet; and allowing 12 inches of thickness for the straw and earth, the height of the finished pit will be $3\frac{1}{2}$ feet, and breadth $9\frac{1}{2}$ feet. The direction of a long pit should always be N. and S., to place *both* its *sides* within reach of the sun's rays in winter, to counteract the effects of frost.

4828. It is found that, when fresh potatoes are heaped together in large quantities, a certain degree of heat arises, which increases as much as to awaken vegetation in the potatoes; and one proof of such heat having existed is evidenced by the long sprouts in the heap when opened in spring. The thick covering of dry straw upon the potatoes may be the means of retaining the heat thus evolved, and hence it has been suggested to leave openings along the ridge of the pit for the heat to escape; the openings to be left at intervals through upright bundles of drawn straw, held together by cord, and cut square on the top, before the earth is thrown up and beaten down near the ridge. These straw chimneys may be seen at *i* and *k*, fig. 435.

4829. To preserve potatoes cool in the pits during winter, it has been recommended to mix earth amongst them and to have no covering above them but earth, in imitation of the state they happen to be left in the ground all winter, when found

in spring quite fresh and good. Potatoes, I know, have been pitted amongst earth, and kept well enough all winter; but the experiments were conducted on too small a scale to recommend the plan for adoption on a farm. It must be admitted that the analogy between this mode of pitting, and of preservation in the field in winter, is far from correct. In the pit one layer of potatoes lies above another, with intervening layers of earth—a relation in which, when one potato rots, it cannot fail to affect the one lying immediately above and below it; whereas in the field every potato lies singly, and in one layer, surrounded by earth, independently of others, and although it should become rotten, it cannot possibly affect any other in the field. Nor is the condition of potatoes improved when stored in cellars or out-houses; for, independent of the heat, the probable dampness of the cellar may cause many to rot; and constant exposure to the air, if not directly conducive to vegetation, will cause as much evaporation of the water of the potato as to produce considerable shrinking. Until, therefore, experience discovers a better plan, the old one of pitting must be followed; and if certain bad effects have been experienced by heating, in consequence of the heaps having been made too large, modifications should be adopted in the construction of pits to avoid the evil complained of. I think that, if potatoes are placed in heaps of the dimensions I have mentioned above, they will run little risk of heating.

4830. It is difficult to explain the different effects which the same mode of pitting produces now that it did twenty years ago and upwards. Then, let the pits be formed ever so large, and the cut-sets heaped on the barn-floor ever so high, either for a long or a short period, not a word was heard of failure; but if there is any truth in the conjecture, that the failure is ascribable to the ordinary mode of pitting, the conclusion is irresistible that some change must have come over the potato itself, since there is none in the pitting. What, then, we all want to know is, *why* whole potatoes heat now in the pit, and cut ones in the barn, when no such effects were seen twenty years ago? Since no satisfactory answer can be given to this question, let the pitting of potatoes in winter, and the

treatment of the cut-sets be changed to suit the altered condition of the plant; but the adoption of a safe change in practice should not induce us to neglect the circumstance that causes the change, nor content ourselves with secondary causes, although a remedy may seem hopeless. This leads us to revert to the rationale of the potato disease, which has been already discussed in (4161) and (4162.)

4831. As long ago as 1843, a foreign cultivator "found that, five weeks after he had harvested a crop from a field planted with diseased potatoes, they began to undergo a dry corruption; and that, even if, externally, they had a sound appearance, they had *internally* a number of the *blue spots*, called stagnation spots, which, when the potatoes were *boiled*, remained *hard*, were rejected by cattle, and which could not be used for the manufacture of brandy, as, besides being unsuited for the purpose, the potatoes would not go through the crushing-mill."* These are precisely the characters of the disease observed in our own potatoes, and they afford infallible means of detecting the existence of the disease.

4832. As expedients have been adopted, during the growth of the potato, to evade the disease on the stems and leaves, and by consequence on the tubers, as has been particularly mentioned from (4153) to (4158); as many expedients have been adopted in the pitting to ward off the disease from the potatoes themselves, but none as yet have succeeded in doing so, far less in staying the plague, after it has manifested itself.

4833. Of such expedients dry materials have been mixed with the potatoes in the pits—for no one has entirely condemned the use of pits—such as dry sand, sawdust, dry powdered peat, ashes of various kinds; and if any of these really prevented the wet rot, they had no power to retard the progress of the dry rot.

4834. Ventilators of various kinds besides those of *i* and *k*, fig. 435, have been recommended in pits, with the view of evaporating the moisture from the potatoes,

and preventing the rot. Such ventilators are conduits for air made of laths and slabs of wood, and of pipe tiles; and although in many cases they apparently checked the first symptoms of the disease, yet where the disease was decidedly active, they proved as ineffective as the expedients mentioned above.

4835. The soil most protective of the potato against disease is *moss*. Out of 32 cases of the cultivation of the potato in moss in England, only 5 suffered much, and 17 little, while 10 escaped altogether; of 31 cases in Scotland, none were bad; of 41 Irish cases, only 2 suffered much, 24 little, and 15 escaped; and of Welsh the one case escaped. It would seem that peat mixed with other manures acts to some extent as a preventive, 2 instances of escape occurring in England, and 15 in Ireland; while no example of failure occurred in England and Scotland, and but 4 in Ireland, and 1 in Wales. The conclusion is—in pure well-drained peat moss, potatoes suffer very little from disease.

4836. On heavy land the disease is considerable. In England 129 cases suffered much out of 163, only 34 escaping; in Scotland the result was better, 16 cases escaping out of 27, the suffering being much in 11 cases; but in Ireland there was no escape, and 11 cases suffered much, and the same was the state with Wales, 2 cases suffering much. And where the heavy land was also wet the proportion of suffering increased: in England it was as 153 is to 34 which escaped; in Scotland 16 to 17; in Ireland 13 to 1; in Wales 4 to none; and on the whole 186 to 51. And if to these rich land is added, the proportion of loss rises still higher, as 237 to 44. The conclusion is, that potatoes in very rich, wet, or heavy land are exposed to disease in a most dangerous degree, as 272 to 9, unless the land is very dry, or the climate cold, or the planting performed in the autumn or very early in spring—so that not more than 1 crop in 30 can hope to escape in such land.

4837. On light land the results were the opposite to those on the heavy: in England the number of escapes being 313

* *Journal of Agriculture*, March 1844, p. 395.

to 79, which suffered much; in Scotland 129 to none; in Ireland 48 to 1; and in Wales 20 to none, the proportion of great disease being about one-seventh. The conclusion is, that in England the chances are 313 to 24 against the appearance of much disease in light lands, unless planting is late, or manuring excessive, or there is a heavy wet subsoil: that is, not more than 1 crop in 13 suffers much in light land, if moderately manured, planted early, and resting on a dry subsoil. In other parts of the kingdom no failures occurred on light lands, except in one instance near Londonderry.

4838. The connection between manures and the potato disease is not so easily traced as is the case of soils, the experience of cultivators being of the most opposite nature. "No doubt can exist as to the cause of these discordant statements. The circumstances under which the trials have been made have not been the same, and therefore the results have also been different. Or, as has commonly happened, effects have been ascribed to manures, which have in truth belonged to other and unsuspected causes." As regards guano, the inference is, that, under all circumstances, two crops manured with guano have been saved out of three; that, if applied to autumn and early spring planted crops, it is advantageous, but that it is dangerous in late planting. The conclusion arrived at in the use of farmyard manure is, that if used abundantly, in a very rank condition, and especially in this state to late planted crops, it is an extremely disadvantageous application. Ashes are a safe manure, when applied by itself, in the proportion of 27 to 4, and when mixed with farmyard dung 54 to 15. Saline manures have not been productive of injury, and are perhaps beneficial. Without manure the results are favourable. In England, 32 cases suffered much, for 96 which escaped; in Scotland 1 suffered for 11 that escaped; in Ireland 1 for 7; and in Wales 1 for 2: the whole giving 35 cases of suffering for 116 which escaped. Nothing is discernible in favour of salt; nor does sea-weed indicate a better effect. The conclusion of the

whole matter may thus be summed up—that over-luxuriance, arising from whatever cause, was highly favourable to the progress of disease, and *vice versa*.*

4839. My belief is, that, if we ever shall be able to check the virulence of the potato disease, we ought to be contented to raise small crops, compared with what we were for many years accustomed to do before the disease appeared, with small quantities of well-prepared manure; and although such a method of cultivation will not give the pecuniary returns which have hitherto been derived from the potato, we must dispense with large crops and large profits, for the sake of again enjoying a pleasant constituent of the dinner table. Overgrown potatoes, forced with inordinate quantities of putrescent manure, are as unpleasant to the palate as precarious to the purse.

4840. "When potatoes are exposed to the action of frost, it is well known that they become soft, and acquire a sweet taste. This taste is succeeded by a sour taste, owing to the rapid evolution of acetic acid, and the root soon passes to putrefaction. From the experiments of Einhoff, we learn that the sugar is formed at the expense of the mucilage; for the other ingredients were found in potatoes sweetened by frost, in the usual proportion. He considers this sweetening process as connected with the vegetative powers of the root." †

4841. Since the removal of the duty, a considerable trade in the import of potatoes has arisen with Holland, Hamburg, Belgium, and France. In 1848 the quantity imported was 940,697 cwt., and in 1849 it increased to 1,417,863 cwt.‡

ON SOWING WHEAT IN AUTUMN.

4842. "How ceaseless is the round of rural labour!" may the poet truly exclaim, for no sooner does the farmer secure one crop than he commences to sow a new one; and his efforts in autumn are exerted to prepare as much land to sow with wheat as he possibly can.

4843. We left the working of summer fallow after the land was dunged, (4172;) and when it was to receive no lime. It is now our business to finish the summer fall-

* *Gardeners' Chronicle*, Feb. and March, 1849. † Thomson's *Organic Chemistry—Vegetables*, p. 481.
‡ Parliamentary Return, February 12, 1850.

lowing, by sowing wheat upon the land so prepared for it. The first process is the levelling of the drills which cover the dung, by harrowing them across a double tine; and, if the land is strong clay, another double tine will be required across the first one.

4844. After the land has been harrowed level, the root weeds that may have been brought to the surface should be removed, but the surface weeds will soon wither in the sun and air.

4845. The land should then be feered, to be gathered up (749,) into ridges; and if thoroughly drained, or naturally dry, one gathering-up will make a good seed-bed; but wet land, to lie safe all winter in the ridge, should be twice gathered-up, (764.) The second gathering-up, however, should not be ploughed immediately after the first, but such an interval of time should elapse as to allow the land to subside, and the subsidence will be much accelerated by rain.

4846. Should the fallow land have had the dung spread upon the surface, and ploughed in with feered ridges, the feerings had been made to leave a half ridge at the side of the field, (4170;) which, now that the land is about to be gathered-up for the seed-furrow, is converted into a whole ridge, to be uniform with those of the rest of the field.

4847. But a practice has come into use since the introduction of the grubber, fig. 215, which possesses advantages on strong land, in certain circumstances, which is, to put the sown wheat into the ground with the grubber, upon the gathered-up ridges which had covered in the dung of the fallow, instead of gathering-up the land again for a seed-furrow; and to finish the work with a double-tine harrowing along the ridges. When the grubber is contemplated to be so used, the land should have been feered for gathering-up in the summer fallow, so as to finish with full ridges over the field, as the contemplated grubbing cannot alter the form of ridges. When a tough waxy clod is expected to arise on ploughing strong land, rather wet below, for a seed-furrow, or when unsettled weather prevails, the grubber will keep

the dry ameliorated soil upon the surface, and accelerate the seed-time considerably.

4848. The land being thus prepared for the seed, the variety of wheat intended to be sown just now should have been selected in time from your own stock, or purchased from that of another. It is quite possible for a part of the new crop to be thrashed out for seed in time for sowing in autumn; but those who sow early in autumn will not have the opportunity of procuring their seed in this way.

4849. Some farmers prefer sowing wheat on fallow land in September; and where there are much bare fallow and strong land, that month may be a proper season to begin. The objection is, that, should the later part of autumn and the early part of winter prove mild, the wheat plant will become proud (2660,) before cold and frosty weather set in to check its growth. October, in my estimation, is the best period for sowing wheat, as it avoids the risk of proud growth, and also of bad weather setting in at the latter part of November, after which no wheat should be sown until the spring.

4850. But although the new crop were secured in good time to afford seed for sowing in autumn, it is better to sow old wheat than new in autumn. New wheat will germinate quicker in the most favourable circumstances of soil and weather than old; but it is more easily affected by bad weather, and by insects; and in consequence its braird is generally neither so thick nor so strong as from old wheat—that is, from seed of the preceding year; for very old wheat may have lost its vitality, even in the stack, or have been much injured by the weevil, (1859,) in the granary.

4851. The varieties of wheat well suited to be sown in autumn are so numerous that a few may be found adapted for every locality. Hunter's wheat has long been a favourite in Scotland, on all classes of soils. The Chidham white wheat is a favourite in many parts of the kingdom, on the best loams. Both belong to the class of wheat represented in fig. 177. Upon inferior soils it is always safest to sow a red wheat, which, although

realising a lower price in the market, will always yield a larger increase. Of the red wheats the Danzig creeping has long stood the test as a hardy, tillering, and prolific variety. This wheat belongs to the second class, represented in fig. 178. As no specific rule can be laid down for a special variety of wheat to be sown in any given locality, you must exercise your own judgment, on hearing the opinions of farmers in your neighbourhood, as to the varieties best suited to your own locality.

4852. Wheat sown in autumn is pickled in the same manner as that sown in spring, (2308.)

4853. Wheat may be sown broadcast, drilled, and dibbled in autumn, and there is no peculiarity in exercising either process at this season. Sowing broadcast is done by the hand, as has already been described in (2319) and (2320.) and with a machine in (2333) and (2334.) The drilling is effected by the machines represented in figs. 205, and 206. The dibbling may be executed by the machines represented in figs. 291 and 292. Broadcast sowing is still most common in Scotland. Drilling is the usual method in England, as also in the neighbourhood of large towns in Scotland, because that form of sowing permits the surface weeds being most easily destroyed by mechanical means amongst growing crops.

4854. The finishing processes of harrowing, described from (2352) to (2358,) and of water-furrowing (2361,) are conducted in the same manner now as in spring; but with this difference in autumn, when water is more likely to stand upon the land, that gaw-cuts (779) must be made with the spade, fig. 237, in hollows on the surface, and across headridges; for, however thoroughly drained land may be, channels must be provided to carry large falls of rain quickly away.

4855. As regards the harrowing, it is of importance to leave the wheat land all winter with a round large clod upon the surface. Such clods afford shelter from wind and frost to the young plants, and, when gradually mouldered by frost, also serve to increase the depth of the loose soil, and give the roots a better hold of it.

Wherever the land is harrowed as fine as meal, in autumn, the rain never fails to batter its surface into a crust, and the frost to heave it up in spring like fermented dough, in which action the plants are raised along with the soil, and left on the surface almost drawn out by the roots, after the subsidence of the earth on the frost becoming thawed by sunshine (2660.) Such an effect can only occur where a considerable quantity of moisture, ready to be acted on by frost, has been retained by the sub-soil immediately under the surface-soil. Draining is the only safeguard against the young wheat plant being thrown out by frost from the ground in that particular manner.

4856. When land is naturally strong enough to grow wheat, and yet is somewhat soft, and as wet below as to make it probable that the plant will be thrown out, (2660,) *ribbing* with the small plough (2626) and (2628) is a better mode of ploughing it, to make it retain the plant, than common ploughing. The wheat is sown broadcast over the ribs, and harrowed in with only a double tine along, (2696.) The ribbing gives the seed a deeper bed in the soil than mere harrowing, and the plant a deeper hold in spring; and it has one advantage in common with the grubber, of moving only the dry surface soil for the seed-bed. Ribbing can only be practised, however, on land that has been ridged up for some time, as the small plough goes too deep, and makes the drills too wide on new-ploughed land. Ribbing is never attempted on land that has not been ridged up, the small plough being unfit to turn up land in a hardened state.

4857. Another mode of preventing the throwing out of the wheat plant on soft land, otherwise well adapted for wheat, is, first, to fcer the land into ridges, fig. 19, sow the seed broadcast between the feerings, cover it with a light seed-furrow, with the common plough, either gathering-up (749,) or casting it (755,) according to the texture of the soil, and leave the land unharrowed and rough all winter.

4858. As the ground is desired to be left in a rough state all winter, no use ought to be made of the roller in autumn.

4859. The land that has grown *beans* is the next sown with wheat in autumn after the bare fallow, with the exception perhaps of the small space which had been occupied by the summer tares, and which may be in the same field with the beans, so that both may form one break to be now sown with wheat. The land after beans and tares is usually feered and gathered-up (749) for the seed-furrow at once, and sown immediately, as the season is far advanced by the time the bean-crop is carried in and stacked; but the seed-bed is in a better state for wheat when the soil is allowed to subside for a few days before the seed is sown.

4860. Where the soil is strong, and the ridges sufficiently round, the grubber may be used on the bean-stubble, as on the fallow-land, to let the wheat, sown broadcast, into the ground; for which purpose a 4-horse grubber will be required. The grubber succeeds in such a case very well, as far as the wheat is concerned, and it has the advantage, in a late autumn, of getting through the work expeditiously; but on strong soil, not thorough drained, and in a comparatively flat state, grubbing is not the best preparation for wheat on bean-stubble; because the seed incurs the risk of rotting in such soil, left in that state all winter, and the soil itself is apt to become sour, from which effect the land would scarcely recover, even if bare-fallowed the succeeding year. Soil thus grubbed requires of harrowing only a double tine along the ridges.

4861. The land that has grown *potatoes*, after which wheat is usually sown, (2699) must be ploughed for a seed-furrow, as upon the drills in which the potatoes were grown the grubber cannot be employed to advantage, that implement leaving the surface in the same form it found it. Only one furrow is given after potatoes, and it is a gathering-up, (749) if the soil is at all strong, and a casting (755) if of light texture. It is better that the soil have time to subside a little, although the usual practice is to sow the wheat upon it as soon as it is ploughed.

4862. I have frequently recommended

the subsidence of the land before being sown with wheat, because that plant always thrives better in soil in a firm state than when it is as loose as the plough leaves it.

4863. Wheat is sown in autumn in a very slovenly manner in many parts of Ireland. The land is sown in the state in which it is left on taking up the potatoes, without being ploughed, grubbed, or dug, and the seed is covered with shovelfuls of earth taken from the trenches or shoughs between the lazy-beds or ridges. The large crops grown after such treatment are surprising. The deep trenches formed between the narrow spaces of ground forming the lazy-beds keep the land dry all winter, and this may be one means of safety to the crop from the injurious effects of undrained land. In Martin Doyle's opinion, this mode of sowing wheat is better than the English one of sowing upon the ploughed land, because it "gives far better and deeper covering to the seed, and thus prevents the plants from being thrown out in the spring, as frequently happens after severe frost, and when the seed has been imperfectly earthed by the harrow, and also allows a moulding to the plants in spring, if the ridges be then harrowed down, as they ought to be, previous to heavy rolling, which is a most important operation."

4864. "It is very common also in Ireland, to sow wheat broadcast on lea, ploughed with as flat and thin a furrow as possible, and to cover the seed by means of the spade and shovel, from the furrows previously ploughed as deeply as possible, for the purpose of yielding earth enough. The clover leas, as well as the rich old pastures, are almost universally treated in this latter way for wheat, where this is the chosen crop in Ireland."*

4865. I have said that wheat sown in autumn requires to be pickled to protect the crop from smut, as well as that which is sown in spring, (2307,) and that arsenic is a dangerous ingredient to employ in any operation of the farm, (4785.) In corroboration of the comparative inefficacy of arsenic as a pickle for wheat, I may adduce the following account of experiments made on purpose to set that point at rest. "Public attention," says Mr E. H. Durden, Dublin, "having been called to the employment of arsenic in agriculture, by a letter addressed by Dr Fuller, of St George's Hospital, to some of the medical journals, I forward you some remarks on the subject, containing the results of the investigation of a commission appointed at Rouen in December 1842, having for its object to determine the best process of preventing the smut in wheat, and to ascertain whether other means less dangerous than arsenic and sulphate of copper (both of which are extensively employed in Great Britain,) were productive of equally good results. The labours of this com-

* Martin Doyle's *Practical Husbandry*—art. *Wheat*, p. 501.

mission extended over the years 1843, 1844, and 1845, and the experiments were repeated two years following on the farm of M. Fauchet, one of the commission, at Boisguillaume, in the department of the Seine Inférieure. My friend M. Girardin, Professor of Chemistry at Rouen, and corresponding member of the Institute, took a very active part as a member of the commission, and drew up a report on the subject, a copy of which he presented to me, and to which I am indebted for the information I now forward to you. As long ago as the year 1779, M. Duhamel du Monceau, in his *Elements of Agriculture*, noticed the employment of arsenic by the farmers of France for the prevention of smut; and whilst speaking of the dangers arising from the use of arsenic for this purpose, expressly points out the dangers arising from the partridges, pigeons, &c., eating the poisoned seeds, and thus endangering the lives of those who used them for food. It would appear that, in the 10 years from 1830 to 1840, there had occurred in France 235 public accusations of poisoning, out of which number 110 were against individuals connected with agricultural pursuits; and it was considered that this arose from the readiness with which they were enabled to obtain poisons, especially arsenic, for the purpose of steeping grain," (471.)

4866. The means used for testing their efficacy in protecting wheat from smut, were—wheat gathered before arriving at maturity whilst the perisperm was still in a milky state: unripe wheat gathered when the perisperm was solidified, but when the epidermis was still green: wheat gathered when the grain and ear were yellow, but when the grain might still be cut with the nail: wheat gathered when the grains had acquired their hardness and transparency: perfectly ripe wheat, not smutty, nor having received any preparation: smutty wheat washed in pure water: smutty wheat plunged for two hours in a solution of sulphate of copper and salt: smutty wheat prepared with sulphate of copper alone: smutty wheat prepared with arsenic: smutty wheat prepared with recently slaked lime: smutty wheat prepared with lime and salt: smutty wheat prepared with sulphate of soda and lime. Of all these means none prevented smut but the first four, with wheat gathered before it had become perfectly ripe. The remaining are placed below in the order of their efficacy:—

- Sulphate of copper and salt.
- Sulphate of copper alone.
- Sulphate of soda and lime.
- Lime and salt.
- Arsenic.
- Washing with pure water.
- Lime alone.

Hence "that sulphate of copper is one of the most powerful means of preservation from smut: that lime produces but very little effect, and its use is even less advantageous than simple washing of the seed in water: that common salt exerts a very marked influence, as the substances with which it is associated acquire a more

decided beneficial action than that which they possessed alone; for instance, lime then becomes very efficacious, and sulphate of copper produces better results than when employed singly: that arsenic does not possess anything like the destructive action on the smut which is generally supposed: lastly, that the mode of steeping the grain in a preparation of sulphate of soda and lime is really very efficacious."

4867. It is interesting as well as useful to ascertain if the different plans of pickling the wheat exert an influence on the produce of the grain and the weight of the straw; and the conclusions drawn from the results obtained were, "that in all respects it is advantageous to employ only sound wheat for seed: that the wheats *least* productive of grain were those which were steeped in arsenic, lime and salt, and lime alone: that the wheats *most* productive of grain were those which were washed in water treated with sulphate of copper, sulphate of copper and salt, sulphate of soda and lime: if the washing with water was favourable to the production of grain, its weight is remarkably diminished: the heaviest wheat of the same bulk or volume is that which has not received any preparation, and next to that the wheat treated with sulphate of soda."

4868. Now, as sulphate of copper is as poisonous as arsenic, it ought not to be used; and sulphate of soda, glauber salts, being innocuous, should be preferred; and, when associated with lime, it proved an almost infallible remedy. But as in no case did the crop escape smut when the seed employed was ripe, which is the usual state of seed wheat, especially for sowing in autumn. It may be said that there is in reality no specific or radical and infallible remedy for smut. The conclusions on the entire experiments are:—"That it is best not to sow seed without steeping: that it is best to make use of the sulphate of soda and lime process, inasmuch as it is more simple and economical, and in no way injurious to the health of the sowers, or inimical to the public health, and that it yields the most productive and soundest wheat: that as arsenic, sulphate of copper, verdigris, and other poisonous preparations can be advantageously replaced by sulphate of soda and lime, the use of the poisonous preparations should be interdicted by the Government."*

4869. With regard to the use of sulphate of soda, perhaps 1 lb. dissolved in 2 quarts of water would answer for 4 bushels of wheat, and the grain then dried with powdered quicklime.

4870. In using old wheat for seed, the probability will be that many grains will have been deprived of their kernels by the wheat weevil, *Calandra granaria*. In steeping the wheat in the baskets in the process of pickling, it is a good precaution with old wheat to stir up the grain in each basket with a stick, and skim off all the grains that float to the top, which the empty husks will readily do.

* *Gardener's Chronicle*, 6th January 1849.

4871. It is said that "in granaries the perfect insect may be destroyed by sorting the grain into conical heaps, when the beetles cluster at the top, and may be taken away in great quantities."* I have observed it somewhere stated, that boards covered with pitch suspended in granaries will inevitably drive the weevils away; and to keep them away the boards have only to be repainted with the pitch. The remedy, being a simple one, might be easily tried.

4872. Mr Hay of Whiterigg in Roxburghshire continued his experiments with dibbling, (3533,) with the view of ascertaining the comparative expense of sowing broadcast, in drills, and with the dibble. For this purpose he divided in the autumn of 1849 two acres of summer-fallowed land (4164) into four portions, each of which was manured with 8 cart-loads of well-rotted farm-yard manure, and ploughed in on 4 ridges of 15 feet in width each.

4873. One of these portions, containing half an acre, was ribbed (2626) into 40 ribs at 18 inches apart, and sown with wheat by the hand (2319,) at the rate of $1\frac{1}{2}$ bushel to the acre, and harrowed in the usual way, (2352.) The expense of the sowing was as follows:—

Seed wheat, $7\frac{3}{4}$ tenths (.775) of a bushel, at 5s. per bushel,	s. d. 3 10 $\frac{1}{2}$
Time of a man and a pair of horses, sowing, harrowing, and water-furrowing, 4 horses at 8s. per day of ten hours,	3 2 $\frac{1}{2}$
	<hr/> 7 1
Cost per acre,	14 2

4874. The tenths of a bushel are most easily obtained by having a measure which contains the tenth part of a bushel, and such a measure will always be found a very convenient one on a farm.

4875. Another of the portions, containing half an acre, was also ribbed with 40 ribs as the above lot was, and sown with wheat, on the tops of the ribs with Newington's dibble, fig. 292, at the rate of $5\frac{1}{4}$ tenths of a bushel (.525) of seed to the acre; and the expense of the sowing was as follows:—

Seed wheat, $2\frac{1}{4}$ tenths (.275) of a bushel, at 5s. per bushel,	s. d. 1 4 $\frac{1}{2}$
Time of a man dibbling, $6\frac{1}{2}$ hours, at 1s. 8d. a-day of 10 hours,	1 1
	<hr/> 2 5 $\frac{1}{2}$
Cost per acre,	4 11

4876. A third portion of ground, containing half an acre, was drilled up in the double way (2397) into 30 drills at 24 inches apart, and sowed with wheat along the top of the drill in a rut made by a field-worker with a hand-hoe, fig. 266, at the rate of $7\frac{1}{2}$ tenths of a bushel (.75) of seed to the acre. The expense of sowing was as follows:—

Seed wheat, $3\frac{3}{4}$ tenths (.375) of a bushel, at 5s. per bushel,	s. d. 1 10 $\frac{1}{2}$
Time of a woman hoeing ruts on the drill, 7 hours, at 10d. per day of 10 hours,	0 7
Time of a man sowing the seed by hand, 5 hours, at 1s. 8d. a day,	0 10
Time of a man and horse covering the seed, 4 hours, at 8s. per day,	3 2 $\frac{1}{2}$
	<hr/> 6 6
Cost per acre,	13 0

This mode would be much better performed if the rut were made on the top of the drill, and the seed sown in it by a machine similar to the bean-drill, fig. 240.

4877. The last portion of ground, containing half an acre, was drilled in the same manner as the last mentioned portion into 30 drills, and wheat sown on the top of the drills with Newington's dibble, at the rate of 4 tenths of a bushel (.4) of seed to the acre, and the cost of sowing was as follows:—

Seed wheat, 2 tenths (.2) of a bushel, at 5s. per bushel,	s. d. 1 0
Time of a man dibbling, $4\frac{1}{2}$ hours, at 1s. 8d. per day of 10 hours,	0 9 $\frac{1}{2}$
	<hr/> 1 9 $\frac{1}{2}$
Cost per acre,	3 7

4878. Some interesting results were obtained by Mr F. King, Thedam, in Essex, on a similar species of experiment. The following are the results of planting 1 grain of wheat to 9 in one hole, allowing 4 holes to the square foot, and taking 14 square feet of ground for the experiment:—

No. of holes in 14 square feet, and 4 holes to the square foot.	No. of grains in each hole.	No. of grains in the square foot.	No. of grains in 56 holes.	No. of ears of corn.	Weight of the ears.
56	1	4	56	205	lb. oz. 3 6 $\frac{1}{2}$
56	2	8	112	250	3 9 $\frac{1}{2}$
56	3	12	168	286	3 11 $\frac{1}{2}$
56	4	16	226	300	3 12 $\frac{1}{2}$
56	5	20	280	304	3 13
56	6	24	336	301	3 6
56	7	28	392	358	3 11 $\frac{1}{2}$
56	8	32	408	352	3 2
56	9	36	504	244	2 2

It will be observed in these results that 7 grains to the hole give the largest number of ears of wheat, 358 in the 14 square feet; but it will be found that that number does not weigh heavier than the produce from 3 grains in the hole; and, besides, the 3 lb. 11 $\frac{1}{2}$ oz. weight of the ears from the 7 grains in the hole is in a somewhat precarious position, as the weight above and below it is 3 lb. 6 oz. and 3 lb. 2 oz. respectively. The heaviest weight of ears, 3 lb. 13 oz. from 5 grains in a hole, is also in the precarious position of being next to 3 lb. 6 oz. So that on the whole I would prefer the produce from 4 grains in the

* *Maunder's Treasury of Natural History*—art. *Weevil*

hole, as being likely the steadiest result of any, since it is as much as 3 lb. 12½ oz., and it is situated in the safe position of being supported by the high weights of 3 lb. 11½ oz. and 3 lb. 12 oz. When the seed is as thickly planted as 9 to the hole, both the number of ears and their weight, diminish very rapidly.

ON SOWING BARLEY IN AUTUMN.

4879. I mentioned in (2702) that barley cannot stand the winter in Scotland as wheat does, but that it does so in the warm calcareous soils in the south of England.

4880. When the winters are mild and the spring dry, as in the south of France, Italy, and Spain, or where the snow lies deep all winter, and the sun is powerful immediately after the melting of the snow in spring, as in Russia, Poland, and North America, barley may be sown in winter. Wherever the winter consists of alternate snows and thaws, and the early part of spring is wet, as is the case in England, Scotland, and Ireland, winter barley is apt to suffer from those vicissitudes, and the spring-sown barley becomes a much more certain crop. In the south of Europe, barley is grown for the horses; but no such inducement exists for its growth in winter in this country where the horses are better fed on oats.

4881. The six and four-rowed, or square-headed barley, is what is termed winter barley, so that the Scotch bere or bigg, fig. a 180, should be the sort best suited for sowing in autumn.

4882. If you determine to sow barley instead of wheat after beans, potatoes, or tares,—for no one would think of substituting the former for the latter on the bare fallow—the culture is precisely the same as for wheat described in (4845,) when the land is to be feered for ploughing; or in (4847,) when the grubber, fig. 215, is to be used instead, or in (4856,) when the land is to be ribbed instead of ploughed or grubbed. Barley may be sown broadcast by hand or machine, drilled by machine, or dibbled by machine, as instanced in the case of wheat in (4853,) and of spring

barley from (2690,) (2693.) The finishing process is the same as described in (2696;) and in (4858) is mentioned the state in which the ground should be left for the winter. When sown after beans, I refer to (4859) and (4860,) and after potatoes to (4861.)

4883. Barley which has stood the winter produces a much heavier grain than when sown in spring.

4884. Barley may be sown in autumn as a forage plant for early cutting in spring, for which purpose it should be sown as early as the end of August or the beginning of September. Thäer mentions a variety of barley, named the Siberian or quadrangular naked barley, *Hordeum caeleste*, which possesses properties of this nature to a remarkable degree—as when sown early, like autumnal corn, it has been cut several times in the course of the summer, and in the succeeding year yielded a good crop; but he regards this account of it as exaggerated. This variety requires a rich, fertile, well-tilled soil, and “it is distinguished from other barley by its plants being fuller, more bushy, and putting forth more blades, even when both kinds are grown on the same soil, and the plants sown at equal distances from each other. The stems which bear the ears are much thicker than those of large barley. The ear is longer than that of small barley, and contains a greater number of grains.”* These are all valuable properties in a forage plant. Its grain is reckoned as valuable as rye for bread and distillation.

4885. I observed in 1849 a rather singular practice in the neighbourhood of Edinburgh, in a field belonging to a cow-feeder, who had sown it with the ordinary flat-eared barley, and as the ground was rich the crop grew luxuriantly. Instead of allowing it to grow, he cut the herbage for green food for his cows, and then gave the aftermath liberty to grow for grain, which it did in about three weeks after the general harvest, and yet in good time to be reaped and carried in good order. The latest aftermath was thin on the ground, but that from the first cutting was

* Thäer's *Principles of Agriculture*, vol. ii. p. 430.—Shaw and Johnson's translation.

a fair crop; and had the whole been cut for forage about the same time, the crop would no doubt have been uniformly good.

4886. "In genial climates, such as Egypt, Barbary, and the south of Spain," says Mr Rham, "two crops of barley may be reaped in the same year—one in spring, from seed sown in the preceding autumn; and one in autumn from a spring sowing. This explains a passage in Exodus, chap. ix. v. 31, where the effect of the hail is mentioned which desolated Egypt, in consequence of the refusal of Pharaoh to let the children of Israel depart,—'The flax and the barley were smitten, for the barley was in the ear, and the flax was balled; but the wheat and the rye were not smitten, for they were not come up.' Commentators agree that this event happened in March; the first crop of barley was therefore nearly ripe, and the flax ready to pull: but the wheat and the rye sown in spring were not yet sufficiently advanced in growth to be injured by the hail."*

ON SOWING PEASE IN AUTUMN.

4887. Pease are not sown in the field in autumn in Scotland, though they are in gardens; but they are sown in autumn in the field in parts of England.

4888. Although manure is never given to pease sown in spring, (2459) it may be afforded in moderate quantity to that sown in autumn. On clean oat stubble the manure, ten cart-loads to the acre, should be spread on the surface, and ploughed in with the common plough; and in every third furrow the seed should be sown in the bottom of the furrow by means of the bean-drill, fig. 219. The ploughed surface would be the better for a double tine of the harrow, to close all the openings left by the ploughing, and to protect the seed and young plants from the frost. The crop may be expected to ripen a little earlier than if it were sown in spring, and the land worked, cleaned, and manured again for sowing wheat upon it in autumn. The after culture of the pea sown now is the same as that in spring, described in (3987,) and its reaping and carrying the same as in (4576.)

4889. Such a course of cropping, however, affords no advantage to the farmer, for when the soil is light enough for pease,

it is better to take a green crop after the stubble, such as turnips or mangold-wurzel; and where it is strong, beans are a much better crop in every respect.

4890. Thäer mentions a practice in a few places in Germany, where "the farmers are in the habit of covering a field sown with pease with a layer of straw, and then leaving the pease to make their way through it, to vegetate. By this means the weeds are all stifled, the soil kept moist; and those stems which fall to the ground prevented from rotting. Where there is a plentiful supply of straw this may be done with advantage, and the straw will afterwards be available as manure."†

4891. Pease may be sown in autumn as an early forage crop in the ensuing spring, which is the most legitimate use this crop can be sown at this season. "In Flanders, pease, beans, tares, and barley are sometimes sown thick together, and form an abundant green crop, which is cut as soon as the flower is past, and given to the cows and pigs, which thrive well on this succulent food. The surface of the ground is so completely shaded, that no weeds can spring up, and as there has been no seed formed, little is taken from the soil. The land is immediately ploughed up, and sown with another crop, such as potatoes and turnips, which sometimes are off the ground in time to allow wheat to be sown the same year."‡

4892. Professor Johnston mentions an instance of a decided discrimination made by the slug in its attack on a field of winter pease. "I lately saw," he says, "at the home-farm of Lord St John, at Meshborne in Huntingdon, a field of winter pease, sown in November 1848, which had been all treated and manured alike, but on one half of which the seed sown was the early maple—a common field-pea; on the other half the Ringwood marrow dwarf—a white pea. The latter was attacked at Christmas by the slugs, and in great part devoured, so as to require filling up with fresh seed; while the former—the grey pea—was untouched by them. There may have been some other reason besides the difference of variety for the limited attack of the slug; but it is obvious that circumstances or liabilities of this kind may materially modify the effect of chemical applications made to our crops, and

* Rham's *Dictionary of the Farm*—art. *Barley*, p. 21.

† Thäer's *Principles of Agriculture*, vol. ii. p. 466—Shaw and Johnson's translation.

‡ Rham's *Dictionary of the Farm*—art. *Pea*, p. 378.

may be the often unsuspected cause of discordances in our results." * I am not surprised at the discrimination evinced by the slugs, as the garden pease, both in the straw and fruit, are much sweeter to the taste than any of the field pease, which have all a bitter harsh taste, as long as they are unripe.

ON SOWING SEVERAL VARIETIES OF GRAIN TOGETHER.

4893. On the continent of Europe it is not an uncommon practice to grow different sorts of the cereal, and of the leguminous crops together, and to reap them together. That practice is studiously avoided in this country, the desire being to have every species of grain as free of admixture from the other sorts as possible. I have heard it recommended to sow more than one variety of wheat together, because bakers aver that the flour is in a better state to make good bread from a mixture of two or three kinds of flour than from one kind. I believe there is much truth in this opinion of the bakers; but their object would be more certainly obtained were the varieties of wheat known to produce the best flour when mixed, mixed together in proper proportions before being ground into flour, than if the same varieties of wheat were sown in those proportions in the field; for, let us sow whatever seeds we please in the field, we cannot be certain of obtaining from them returns in any given proportion to those sown, and the uncertainty increases as the varieties of the seed sown are increased in numbers.

4894. It is quite correct in theory to expect an enlarged yield by sowing different varieties of grain together, since different varieties of plants take different kinds and quantities of ingredients from the soil in different proportions; and the theory is the more strikingly illustrated by growing plants together of very different natures, such as the cereals and legumes. Experience supports the theory as being correct thus far: but then, to obtain the full results of the theory in practice, the different sorts of grain grown together must reach maturity at the same time, otherwise one variety will be in-

jured for the others: at all events, if the seasons of their maturity are not exactly the same, the entire crop must be reaped when the plant which grows the more vigorously, or ripens the more quickly, has attained the stage of maturity. In such a case the other plants may ripen after they have been cut down, as does buckwheat; or they may be useful although not attained to full maturity, as in the case with oats. Thus, so many considerations which amount to difficulties attend the growth of mixed crops that it is better not to attempt it. Were the object merely to obtain a rank growth of forage, two or three varieties of plants may be grown together as exhibited in (4891;) but this entirely misses the end aimed at—to obtain a superior material for bread, or food for horses, as well as a greater return.

4895. The most common mixtures grown on the Continent are wheat and rye for bread, which is said to be agreeable and nutritious, and the mixture is called *meslin*. Flat barley and oats are grown together, the oats always predominating, and both are said to give a large yield. Some persons add spring rye to their mixture on light soils. The most common mixture of cereals and legumes is that of oats and vetches, which makes good food for cattle when prepared with the chaff-cutter, whether the crop be allowed to ripen or be mown in a green state; and both barley and spring-wheat are also sown with vetches. Pease in small quantities are associated with spring-wheat, and the quantity of wheat, it is said, is not thereby diminished. On sandy soils, pease are associated with spring-rye. On calcareous, clayey, and meagre soils, it is usual to sow beans amongst oats. A mixture of beans, vetches, and oats are grown together for the purpose of a green food for cattle, and goes by the name of *beans*. It is cut when the seeds begin to form, and in some countries the horses are entirely fed on it. The character of the mixture is determined by the nature of the soil: in clayey soils the beans are increased in quantity, and in the lighter soils more vetches are used. Vetches are also mixed with buckwheat, when the crop is to be cut in a green state.†

* Johnston's *Experimental Agriculture*, p. 16.

† Thäer's *Principles of Agriculture*, vol. ii. p. 486-9—Shaw and Johnson's translation.

4896. Some farmers in Scotland sow different varieties of oats together, and oats only of all the cereal grains. The practice had probably originated in some varieties of that grain having occupied the ground too sparsely. The Georgian oat, for example, which was brought into notice rather more than twenty years ago, always came up and grew thin, whatever quantity of seeds were sown; and even the Hopetoun oat, though otherwise a good variety, indicates a similar habit of growth. To fill up the spaces thus left in the ground by the Hopetoun oat, other varieties are sown with it in certain proportions, according to the situation and nature of the soil—and the compound crop is superior to either of the single ones. I know no farmer who has carried this experiment to a greater length than Mr Finnie, Swanston, near Edinburgh; and the following table shows the results of some of his experiments:—

	Bushels.
Potato oats alone, produced, per acre,	59
Hopetoun,	52
Early Angus,	62
Kildrummie,	62
Dun,	61
Blainslie,	56
Grey Angus,	51
Sandy—seed changed,	49
Sandy—seed unchanged,	45
5 of Hopetoun and 1 of Kildrummie produced, per acre,	68
5 of Hopetoun and 1 of Sandy,	64
5 of Hopetoun and 1 of Early Angus,	61
5 of Potato and 1 of Early Angus,	53
5 of Potato and 1 of Sandy,	58

It is thus seen that mixtures with the Hopetoun produced larger crops than did the Hopetoun alone, and their effects were the opposite upon the potato oat.*

4897. We constantly read in the foreign corn reports of mixed wheats, the different grades being four—White, High-mixed, Red mixed, and Red wheat. The White is a mixture of pure white wheats. The High mixed has a very small mixture of red. The Red mixed has perhaps a third of red wheat in it; and the Red wheat is a mixture of red wheats. In Upper Poland, where the finest wheat is raised, it is nearly all white, or all High mixed; and as the soil and climate

become indifferent, the red wheat prevails; and the white wheat becomes red after a few repetitions of sowing it in unfavourable circumstances.

ON PLANTING POTATOES IN AUTUMN.

4898. Amongst the expedients suggested for evading the potato disease, none has been more confidently recommended than planting the sets in autumn; but the suggestion has been but partially adopted. The planting of such a crop in autumn cannot, in truth, be practised everywhere, nor extensively in ordinary circumstances; because potatoes being not only a green, but a fallow crop, and a green crop being always taken after one of grain, the stubble of the grain crop is generally not in a fit state to receive the manure, before undergoing the process of cleansing by means of the plough, the harrow, and the grubber, as the land for a fallow crop ought to be; and, in Scotland at least, too short time intervenes from the harvest of the grain crops to the occurrence of bad weather in the early part of winter, to permit the land to be cleaned in a satisfactory manner. Hence very few cases can occur in which the stubble may be manured in October, for a crop that is to occupy so important a position as every green crop does. This is one reason, and it is a sufficient one, why so few cases of autumnal planting takes place in the potato; and the obstacle to it is to be regretted, since in the few cases attempted the result has proved advantageous. Out of 64 English and Welsh returns of the crop of 1849, 53 were in its favour and only 11 against it; and no bad cases were reported in Scotland, while there were 4 good. The conclusion arrived at was, that autumn planting was a greater safeguard from disease than that of early spring. In England, the autumn planted, with that of the months of January and February, was better in the ratio of 13 to 11; and in Scotland, March may be taken, after the autumn, as the best month, the ratio of loss being only $7\frac{1}{2}$ per cent. The general conclusion over the kingdom, in 1849, was that the earlier the potato

* *Transactions of the Highland and Agricultural Society, July 1850, p. 316.*

planting is performed the *better*, and the later the *worse*.

4899. A rather unexpected corroboration has been given, in 1850, of a curious and important fact observed in 1846—that diseased potatoes may be safely and advantageously used for seed. Mr Benjamin Smith of Wokingham, Berkshire, planted *very much diseased* sets of ash-leaved kidneys on the 18th of March, in drills 5 inches deep, and the crop was taken up sound and ripe on the 2d of August, *without disease*; while sound sets of ash-leaved kidneys and others, a mixed lot, were planted in February as before, and on being taken up in August, were found to be *much diseased*. *Very rotten* late potatoes were planted in November 1849, 6½ inches deep, covered first with two inches of earth, then by a layer of half-decayed weeds, and lastly by earth, and the crop was taken up in the beginning of August *without disease*. A blacksmith in Wokingham, Abraham Lewis, experienced the same results on the 8th of August 1850.

4900. It is the opinion of Mr Smith that diseased sets are much better for planting than sound ones. The former soon rot when the live part has begun to grow; the latter are apt to remain hard, fleshy, and brittle, even when the new crop is ripe; and he thinks that, in the former case, there is an effort of nature to throw off the disease. On this Professor Lindley remarks, that “it is possible that the morbid matter which causes disease may disappear in the general decay of the tuber in the one case, and may remain unchanged in the other, prepared to seize upon the haulm as soon as it is ready to receive its influence. At least, no better explanation of this curious fact presents itself to us at present: but the fact itself is certainly, in practice, very valuable.”*

4901. The method of planting potatoes in autumn is precisely the same as in spring, which has been particularly described from (2745) to (2754); but there will not be time to stir the land so much as is recommended in (2733) and (2734.)

The stubble should get one furrow with the plough, in the contrary way the ridges are formed. Harrowing along and across the ridges a double time should then be given, and any weeds that may have been brought to the surface by it should be gathered off. If there is time, the grubber, fig. 215, should be used across the ridges to cut into pieces the furrows made by the plough; but should there not be time for this efficient operation, the land must be drilled up in the double way (2397) in preparation for the dung. The farther operations go on as stated in (2745) and succeeding paragraphs.

4902. I think it advisable to use whole potatoes for seed instead of cut sets, in the autumn; for which the small ones will answer the purpose well, (2739,) and the time will be saved that would have been occupied in the cutting. The whole potatoes must be planted in the drill at wider intervals than cut sets are,—from 10 to 12 inches asunder.

4903. Much attention is required at this season, after committing any crop to the ground, to have surface channels cut with the spade, (779,) wherever there is a hollow in which the least chance of water may stand for a time, as also across the lower headridge into the adjoining ditch, or outfall of the field.

ON THE EFFECTS OF SPECIAL MANURES.

4904. For a very long period in the practice of agriculture, no other manure was put upon the soil but what was obtained from the straw of the cereal crops, from the leaves, bulbs, and tubers of the green crops, and from the dung voided by the different kinds of animals supported upon the farm, as also the materials obtained from the streets, and houses, and stables and byres of towns. The manure made upon the farm was, and has always been emphatically termed, *farmyard manure*, and that derived from towns was called *street* or *police manure*. Those manures served to support the heart of the soil, as long as farmers were contented

* *Gardeners' Chronicle*, 17th August, 1850.

to spread over that part of its surface every year what was made on the farm; and if more or less manure was thus made, according to the favourable or unfavourable circumstances attending the crops in different seasons, the soil received all that was made. It is the practice still what it was then, of the street manure being used only on the farms in the immediate neighbourhood of towns, in lieu of the straw, the grass and the hay, and the turnips sold by them to the cowfeeders and stable-keepers in towns. But after the demand for green crops extended—whether from towns, or from the necessities of the farm itself, in feeding live stock to heavier weights or at an earlier age—other manure to assist that of the farmyard was inquired after by farmers at a considerable distance from towns, who knew that no such material could be procured from towns, but at an unreasonable cost. It is thus that *bone-dust* was first employed to extend the turnip culture, and at a later date *guano* was purchased at a high price, to attain the same end. In prosecution of similar ends, at a still later period, many simple substances have been used with a view to evolve the peculiar properties of each of the many varieties of plants cultivated; on which account those substances have obtained the name of *special or specific manures*, (205.)

4905. Let it be understood that I do not place farmyard manure, bone-dust, and guano in the category of special manures, as they all possess properties which benefit in a greater and less degree every species of crop; nor should I call those manures special which have avowedly been concocted as substitutes for bone-dust and guano.

4906. Time has not yet decided which one of the special manures is the most beneficial to all the crops, although, doubtless, some one does possess that property; nor has experience yet proved whether special manures are equally beneficial in all soils, situations, and seasons; but sufficient time has already elapsed to decide, that the special manures in which certain ingredients preponderate are not only more beneficial generally than those which want those constituents, but are necessary for the healthy development of plants. The

necessary ingredients referred to are the compounds of ammonia and phosphorus. Ammoniacal salts and phosphates thus stand at the head of the list of special manures. It is, no doubt, on account of the valuable properties of those ingredients which render farmyard manure, bone-dust, and guano so great favourites with farmers.

4907. But although farmyard dung is not of itself a special manure, such manure cannot be treated of irrespective of that important material; for experience has already proved that their value is evinced more as auxiliaries to farmyard dung than in intrinsic properties possessed by themselves. The same remark applies also to guano and bone-dust, which in this respect stand in the same relation to farmyard manure as the special manures themselves.

4908. In consequence of the great number and varieties of the special manures which have been presented to the notice of farmers by chemists and others, space will not permit me to relate even a small proportion of the results which have already been obtained from their application in multiplied combinations to every species of crop raised on the farm. Suffice it to examine only the *largest* results obtained from each of the crops, whether the manure was applied singly, or in combination with others, or with farmyard manure. It will be right, however, at the same time, to show in a distinct manner the relative value, as manures, of farmyard dung, guano, bone-dust, and the special manures; but before proceeding to state particulars, it is necessary to remind you of the composition of farmyard manure, given in (2025,) (2028.) and (2029.) and of that of the urine of animals in (2094,) (2096,) (2100,) (2101,) and (2102.) The analysis by Sprengel, in (2094,) gives the general composition of the fluid and solid excrements of animals; and the analyses by Boussingault were evidently made from dripping fresh dung, unlike the state it is usually applied to the soil; but the analysis made by Mr Richardson was from farmyard dung as it is applied to the field, and is therefore the most interesting to the farmer. It will be found in the accompanying table, where all the constituents

are conveniently given in proportions to one ton of prepared dung.*

Water,	In one ton.
Organic matter, containing 16·584 lbs. ammonia,	1455·104 lb.
Potash,	553·504 ...
Soda,	7·481 ...
Lime,	6·317 ...
Magnesia,	21·427 ...
Alumina,	4·337 ...
Manganese,	trace.
Peroxide of iron,	trace.
Silica,	4·623 ...
Carbonic acid, with earths,	62·545 ...
Sulphuric acid,	11·393 ...
Phosphoric acid,	7·571 ...
Chlorine,	17·468 ...
Sand,	7·280 ...
Carbon,	71·702 ...
Alkali, and loss,	1·926 ...
	7·282 ...
	<hr/>
	2240·000 lb.

Any other remarks regarding farmyard manure than what are contained in these references, supposes the dung to be in the best state for applying to the land, which is the sappy rich state, neither too wet nor too dry; the utility of which is thus explained by Dr Henry R. Madden:—“Whenever dead organic matter, either animal or vegetable, is exposed to air in a moist state, it absorbs oxygen, which, by entering into combination with its carbon, destroys its original composition, and gives rise to the production of various new compounds, which in their turn suffer decomposition by means of fresh supplies of oxygen being absorbed, and so on in a continued series, until the whole mass is reduced to chemical compounds of such stability as to resist the further action of oxygen under ordinary circumstances. During this series of changes, the various solid compounds are converted first into fluid and then into gaseous products; which latter, by escaping into the air, become lost. Chemists are much divided as to what precise amount of decomposition is requisite to render organic matter in a proper state to become food for plants; all agree that decomposition must have commenced; some maintain that it must be completed. My own belief, founded on extensive observation and not a few experiments, is, that all the products of decomposition, in every stage, are available as food for plants, provided they are either liquid or

capable of dissolving in water. These observations will, of course, regulate us in the management of the ‘midden.’ Whenever any moist organic matter absorbs oxygen, its chemical union with its carbon gives rise to an increase of temperature, which increase enables the surrounding portions to absorb oxygen more rapidly than they otherwise would do; these parts in their turn become heated, and thus the influence extends through the entire mass, the amount of heat being proportionable to the size of the mass, its degree of moisture, and quantity of air contained in its interstices. By careful management you can retard or accelerate the fermentation of your ‘midden’ to almost any extent, from scarcely any change taking place, to so great a rapidity as to endanger the whole taking fire from the heat evolved. The most profitable way for dung to ferment is slowly but steadily, so that, by the time it is required for use, it will readily cut with a spade like soft cheese, and exhibit a uniform rich brown colour, and emit no smoke unless the air be very frosty. During fermentation, the azote contained in the various constituents of the dunghill unites with hydrogen, and forms ammonia or hartshorn, which being very volatile, is apt to escape with the watery vapour and other gaseous products of decomposition. Various means have been of late recommended to prevent this, but none of them appear to me at all satisfactory, and, I believe, have not as yet given very satisfactory results when applied to practice. The best condition for a ‘midden’ to be in is, when it contains a sufficiency of water to cut moist, and yield a little liquid by pressure, but not enough to run from it spontaneously; this is easily effected by draining the ‘midden’ stance, if in the court, so that all superfluous moisture runs off into the drains, which, of course, must lead to the liquid manure-tank, from which in dry weather it should be pumped up and scattered uniformly over the ‘midden.’ In this state of moisture, scarcely a perceptible quantity of ammonia is lost, as it all remains in solution; and I believe that this plan will be found in all cases to be superior to every other hitherto devised for preserving farmyard dung.”

* *Philosophical Magazine*, July 1845.

4909. I know of no more particular analyses of bone-dust than what are given in (3331) to (3334.) The following table may prove useful in applying certain quantities of bone-dust to the acre. An example will best illustrate its use: Supposing that the drills are 36 inches apart, then 10 bushels of bone-dust should manure 484 yards along such a drill to give the land 10 bushels to the acre. The width between the drills is confined from 24 to 36 inches, the limits of practice, in different parts of the country, in cultivating green crops. The bushels per acre do not extend beyond 16, which are found to be the maximum quantity that produces the greatest results. When two drills are manured at the same time, half the distances in the table must of course be taken.

Number of inches between the drills.	Number of yards along one drill in an acre.	Number of bushels per acre, which should extend along the preceding yards on a drill.						
		10	11	12	13	14	15	16
36	4840	484	440	403	372	345	320	302
35	4978	497	452	414	382	355	331	311
34	5124	512	465	427	394	366	341	320
33	5280	528	480	440	407	377	352	330
32	5445	544	495	453	418	388	363	340
31	5620	562	510	468	432	401	374	351
30	5808	580	528	484	446	416	387	363
29	6008	600	546	500	462	422	400	375
28	6222	622	565	518	478	444	414	388
27	6453	645	586	537	496	460	430	403
26	6701	670	609	558	515	478	446	418
25	6969	696	633	580	536	497	464	435
24	7260	726	660	605	558	518	484	453

4910. Professor Way has analysed such a great variety of guanos since the analyses of Professor Johnston in (3349,) that I must abstract a few of his results, as they will be found highly interesting to the farmer. From the small quantity of guano that may now be expected from the African coast and from Patagonia, any other kind than the Peruvian need not attract the attention of the farmer, at whatever price it may be offered in the market. Another consideration beside quantity renders any guano but the Peruvian of little value to the farmer, which is, that as guano is chiefly employed for the sake of its ammonia, the African and Patagonian kinds being composed chiefly of phosphates of lime, are not suitable as substitutes for the Peruvian, which contains

a large proportion of the ammonical compounds, as may at once be seen by the following comparison. The ammonia is as follows:—

In Peruvian guano, (32 specimens,)	17.41 per cent
Ichaboe, ... (11 ...)	7.30 ...
Patagonian, ... (14 ...)	2.54 ...
Saldanha Bay, ... (20 ...)	1.62 ...

The phosphate of lime is as follows in the same specimens:—

Peruvian guano, . . .	24.12 per cent.
Ichaboe, . . .	30.30 ...
Patagonian, . . .	44.60 ...
Saldanha Bay, . . .	56.40 ...

As all guanos have no doubt originated from a similar source, every ton of the Saldanha Bay may be regarded as two or more tons of the Peruvian, from which fermentation and rain have removed the greater part of its ammoniacal compounds.

4911. Below are four of the analyses of Peruvian guano, exhibiting the largest proportions of ammoniacal compounds and earthy phosphates, out of 44 analyses of specimens imported in 1847, 1848, and 1849, by Messrs Anthony Gibbs and Sons, *now*, 1850, the sole importers of the true Peruvian guano, (3351.) I say of the *true*, because other varieties are imported from South America, from Bolivia and Chili, which are represented as the Peruvian, although they are more nearly allied to the Ichaboe than it, (3349):—

Water, . . .	16.16	8.88	11.24	8.97
Organic matter and Salts of ammonia, }	57.13	58.82	55.17	57.64
Sand, . . .	1.17	1.36	1.46	1.12
Earthy phosphates, . . .	19.46	25.27	27.89	23.58
Alkaline salts, . . .	6.08	5.67	4.24	8.69
	100.00	100.00	100.00	100.00
Ammonia from 100 parts, }	18.94	17.86	18.27	18.56

4912. The following table contains an analysis of Angamos guano, a variety which comes from Peru, and is known there as a recent deposit, and is collected by hand. It is very rich in ammonia, and somewhat whiter in colour than the ordinary Peruvian. The other analyses are each the best specimen of Ichaboe from 11 specimens, of Patagonian from 14 speci-

mens, and of Saldanha Bay from 20 specimens.

	Anga- mos.	Icha- boe.	Pata- gonian.	Saldan- ha Bay.
Water,	16.29	26.5	27.0	15.27
Organic matter and Salts of ammonia,	58.84	41.0	28.5	23.28
Sand,	3.29	0.3	6.0	3.07
Earthy phosphates,	14.69	28.7	41.5	49.01
Alkaline salts,	6.89	...	...	...
	<u>100.00</u>			
Ammonia,	<u>20.07</u>	<u>9.5</u>	<u>3.25</u>	<u>2.49</u>

4913. Of true guanos, the important constituents are ammonia or its elements, phosphate of lime, and potash; and of the remaining constituents the water and sand are valueless; and the sulphuric acid, the lime, the chlorine, and the soda, can be easily and cheaply supplied by gypsum and common salt. Estimating the essential elements of Peruvian guano at the market price, and taking its average composition from the numerous analyses mentioned above, its intrinsic value per ton should be as follows:—

Ammonia,	17.41 per cent, = 388 lbs. at 6d. per lb.	£9 14 0
Phosphate of lime,	24.12 .. = 540 3d. ..	1 13 9
Potash,	3.5 .. = 78½ 2½d. ..	0 14 8
		<u>£12 2 5</u>

The only other substances from which ammonia might be easily supplied, are the muriate and sulphate of ammonia. Muriate of ammonia, being at least £19 per ton, is too expensive for agricultural purposes; and even the sulphate of ammonia, at £12 per ton, is dearer than Peruvian guano at £10 per ton, for which the farmer buys ammonia at the same price as that afforded in the sulphate—while he gets the phosphate of lime and the potash for the extra 6s., between the value of the phosphate of lime and potash, £2, 8s. 5d., and the balance between the above sum and £10.*

4914. Uric acid being only obtainable from one or two sources, such as the solid urine of serpents, or the dung of sea-fowl, which latter in fact is guano, Professor Way considers guano a manure of its own peculiar kind, and that it is impossible to produce a perfect imitation

of it. We thus have the explanation why the manufactured guanos have not proved so efficacious as the natural production.

4915. It may be convenient to have a table showing the quantities of guano applied to an acre, when a given small quantity covers a certain number of yards along the top of a drill, at a given distance from another drill.

Number of inches be- tween the drills.	Number of yards along a drill in an acre at those dis- tances apart.	Number of yards along a drill, manured with 1 lb. of guano, equal to 1 cwt. the acre.
36	4840	43
35	4973	44
34	5124	45
33	5280	47
32	5445	48
31	5620	50
30	5808	51
29	6008	53
28	6222	55
27	6453	57

This table requires this farther explanation. As regards the third column, an example will best explain it. Supposing that 1 lb. of guano extends 43 yards along the top of a drill which is distant 36 inches from the nearest one, then 1 cwt. will be given to the acre; if 2 lb. are thus spread along the same 43 yards, then 2 cwt. will be applied; if 3 lb. then 3 cwt., and so on for any number of cwt. desired to be given to the acre. When the drills are closer set, the lb. of guano will have to extend along a greater number of yards to afford 1 cwt. to the acre: thus, at 27 inches asunder, the pound of guano will require to go along 57 yards of a drill to give 1 cwt. to the acre.

4916. In applying guano, it should be kept in mind that all seeds, and sets of tubers, when placed in the drill in *contact* with it, will be injured, and most likely deprived of their vitality. A portion of earth should therefore always intervene between the seed and the guano.

4917. It is also useful to remember, that a top-dressing of guano to a crop will often convert the loss that would accrue from it to a sensible gain, and therefore no farmer should grudge to try a top-dressing of guano on any crop, if the weather is favourable for its application, which it only is when in a moist condi-

* *Journal of the Agricultural Society of England*, vol. x. p. 202-25.

tion; because all organic manures, of whatever kind, become inert, or even mischievous, in the soil in the absence of rain or sensible moisture. All mineral manures are supposed to act upon organic ones, so as to extend and equalise their action, and thus render them more durable in the soil.

4918. *Wheat*.—Having thus cleared the way in explaining the nature of the manures most to be relied upon by the farmer, and made a few general observations on their mode of application, it is now time to consider the effects of the special manures upon the crops commonly raised on the farm, and we shall begin with *wheat*.

4919. Mr Alexander F. Gardner, steward to Mr Fleming of Barrochan, Renfrewshire, applied 5 cwt. of *rape-cake dust* to the acre, at a cost of 33s., as a top-dressing, on the 12th of May 1843, on white Hunter's wheat, sown in October 1842, and obtained 48½ bushels of wheat of 62 lb. to the bushel, and 1224 stones of straw from the acre. That which received no dressing yielded 32 bushels of wheat of 62 lb., and 824 stones of straw. The increase produced by the dressing was therefore 16½ bushels of wheat, and 400 stones of straw to the acre, affording a profit thus:—

16½ bushels wheat at 5s.,	£4 1 3
400 stones straw at 2d.,	3 6 8
	<hr/>
	7 7 11
Deduct cost of rape-cake,	1 13 0
	<hr/>
Profit,	£6 14 11

The soil was a stiff loam about 9 inches deep, subsoil stiff yellow till, full of small stones, superincumbent on sandstone, had been thoroughly drained, and dug. The wheat was sown after potatoes, which had been manured with 36 cubic yards of farmyard dung; was reaped on 15th September, and weighed in the second week of October.*

4920. Mr Alexander James Main, steward to Mr Wardlaw Ramsay of Whitehill, Mid-Lothian, applied 13 cwt. of *nightsoil* to the acre, at £5 per ton, at a cost of £3, 5s. an acre, as a top-dressing, spread on

20th May 1845, upon wheat sown on the 27th September 1844, which had been manured with 13 cwt. of *rape-cake dust* to the acre, at a cost of £3, 5s., and obtained on the 24th September 1845, 48 bushels of wheat of 52 lb. to the bushel, and 440 stones of straw. The land that had been manured with the *rape-cake* only yielded 36¾ bushels of wheat of 54 lb. to the bushel, and 390 stones of straw. The increase realised by the dressing was therefore 11½ bushels of wheat, and 50 stones of straw, incurring this loss:—

11½ bushels wheat at 5s.,	£2 16 3
50 stones straw at 2d.,	0 8 4
	<hr/>
	3 4 7
Deduct value of nightsoil,	3 5 0
	<hr/>
Loss,	£0 0 5

The soil was a moderately heavy clay, resting on a pure red chattery clay, very difficult to work, the pick being obliged to be used in its drainage, when it afforded a good deal of under water. This experiment was made on rising ground with a considerable acclivity to the S.E. Previous to being drained, the ground was very wet; and now it is of superior quality, and of much increased value. The soil was to undergo subsoil ploughing in the ensuing winter.†

4921. He tried the effects of a salt, *saltpetre refuse*, obtained from powder-mills, of which he applied 3 cwt. to the acre, at 14s. the cwt., at a cost of £2, 2s. to the acre, and obtained 57½ bushels of Hopetoun wheat of 53⅔ lb. to the bushel, and 354 stones 4 lb. of straw. The ground not manured with the *saltpetre refuse* yielded 40 bushels of wheat of 54½ lb. to the bushel, and 217 stones of straw. The increase of crop derived from the dressing was 17½ bushels of wheat, and 137 stones 10 lb. of straw. The results stand thus:—

17½ bushels of wheat at 5s.,	£4 7 6
137 stones of straw at 2d.,	1 3 9
	<hr/>
	5 11 3
Deduct the value of the salt- petre refuse,	2 2 0
	<hr/>
Profit,	£3 9 3

* *Transactions of the Highland and Agricultural Society*, July 1844, p. 238.

† *Ibid.*, October 1846, p. 406 and 422.

This experiment was made on the same ground as on that of the preceding experiment. The wheat was sown in October 1846, after potatoes that had been manured with 20 tons to the acre of farmyard dung, and which completely failed. The top-dressing was sown broadcast on the 18th May, and the crop was reaped on the 1st of September 1847.*

4922. Mr John M'Lintock, Harley Works, Glasgow, tried the effects of using a similar ingredient, pure *saltpetre*, (nitrate of soda,) as a top-dressing at two distinct periods of the same season on the same field of wheat. The first top-dressing was made on the 17th April 1843, on wheat that had been sown after potatoes in 1842, with 28 lb. of saltpetre to the acre, and the second of 56 lb. was applied on the 6th of May on wheat sown after turnips, and the cost of both applications was 21s. 9d. an acre. The produce obtained was 52 bushels of 59 lb. of wheat, and 321 stones 6 lb. of straw to the acre. The part of the same field that was not top-dressed, but had been manured with guano for the turnips, and with 10 tons of ash dung for the wheat, yielded only 44 bushels of wheat of 58 lb. to the bushel, and 225 stones of straw to the acre, giving an advantage to the top-dressing of 8 bushels of wheat, and 96 stones of straw, which may be stated in this manner:—

8 bushels of wheat at 5s., . . .	£2 0 0
96 stones of straw at 2d., . . .	0 16 0
	2 16 0
Deduct the value of the saltpetre, 1 1 9	1 1 9
Leaving a profit of	£1 14 3

The soil was sandy heavy loam, and had been drained in 1841 to the depth of 22 inches. The effects of this experiment would have been more satisfactory had a top-dressing of both the quantities of saltpetre at one of the above periods been made with a view to comparison, but as much as both the quantities, namely, 84 lb. of saltpetre, at the same cost of 21s. 9d. per acre, was top-dressed at one of the above periods—namely, the 17th of April, on wheat that was sown after potatoes on the 7th November 1842, on deep sandy loam of another field, whose produce may be

stated as a means of comparison with the above result. It was 41 bushels of wheat, of 60½ lb. to the bushel, and 224 stones of straw; but as this result is less than the produce of the same field which had received no top-dressing at all, we would be induced to conclude that the larger quantity of saltpetre applied at once as a top-dressing had had an injurious rather than a beneficial effect.†

4923. These instances give the effects of the application of single substances. Mr Main tried the effects of the combined action of *nightsoil* and *nitrate of soda* on wheat: 1½ cwt. of nightsoil at 4s. = 6s., and 1½ cwt. of saltpetre at 19s. 6d. the cwt. = 29s. 3d., at a cost of £1, 15s. 3d. an acre, produced 55 bushels of 53 lb. the bushel of wheat, and 363 stones of straw. This experiment being a part of the one related in (4921,) where the part undressed with special manures gave 40 bushels of wheat, and 217 stones of straw, the increase received by the top-dressing was 15 bushels of grain, and 146 stones of straw. The results were thus:—

15 bushels of wheat at 5s., . . .	£3 15 0
146 stones of straw at 2d., . . .	1 4 4
	4 19 4
Deduct the value of the manure, 1 15 3	1 15 3
A profit is left of	£3 4 1‡

4924. Mr Main tried the effects of the combined actions of several specific manures on Hunter's wheat, which was raised on light clay soil, resting on an impervious clay subsoil, many parts of which was full of stones, and naturally very wet. It was drained in 1846 at 17 feet apart, and 2 feet deep, and a beneficial change was the consequence. The field is bounded on three sides with woods; the exposure is from S.W. to N.E., and there is a gentle acclivity in the line of exposure. The land was bare fallowed after being drained, and manured with 18 tons of farmyard dung, and 6 cwt. of rape-cake dust an acre. The wheat was sown in the autumn of 1846, and cut on the 10th, and weighed on the 15th of September 1847. The special manures consisted of—

* *Transactions of the Highland and Agricultural Society*, March 1849, p. 492 and 513.

† *Ibid.*, January 1849, p. 416 and 437.

‡ *Ibid.*, March 1849, p. 492 and 531.

Bones, dissolved, . . . 104 lb. at 7s. the cwt.,	L.0	6	4½
Sulphuric acid, . . . 52 .. at 12s. ..	0	5	6½
Carbonate of potash, . . . 26 .. at 35s. ..	0	8	1½
Carbonate of soda, . . . 17 .. at 12s. ..	0	1	9½
Carbonate of magnesia, 60 .. at 22s. ..	0	11	9½

L.1 13 8

This mixture was not applied, from fortuitous circumstances, until the 31st May 1847, and drought set in immediately thereafter; but the produce obtained was 54¾ bushels of 52 lb. of wheat, and 263 stones of straw, while the land that was not top-dressed only gave 45¼ bushels of 52½ lb. of wheat, and 202 stones of straw—the difference in favour of the top-dressing being 9½ bushels of wheat, and 61 stones of straw. The result stands thus:—

9½ bushels of wheat at 5s., . . .	£2	7	6
61 stones of straw at 2d., . . .	0	10	2

2 17 8

Deduct the value of the manure, . . .

1 13 8

A profit is left of . . . £1 4 0*

4925. *Barley*.—Mr A. F. Gardner obtained at Barrochan from a soil, upon the side of a hill with a southern exposure, of light brown loam of medium quality, resting on stiff strong till of great depth, lying between trap and sandstone, thoroughly drained, trenched out of lea 12 inches in depth with the spade, at a cost of £3, 6s. 8d. an acre, and manured with 3 cwt. of guano to the acre, at a cost of £3, 15s., a produce of 64 bushels of common barley per acre, of 54 lb. to the bushel, and 321 stones of straw. The ground with which the experimental lots were compared was dressed with 2 chaldrons of quicklime slaked with water, in which common salt had been dissolved, and with 2½ cwt. of Turnbull's dissolved bones in muriatic acid, and the return was 48¾ bushels of barley of 55¼ lb. to the bushel, and 220 stones of straw. The guano procured an increase of 15¼ bushels of grain, and 101 stones of straw. The cost of Turnbull's manure not being given, I am unable to estimate the profit derived from the guano. The barley was sown on the 14th April, top-dressed in the beginning of May; reaped on the 25th August, and weighed on the 15th October 1842.†

4926. Mr John Finnie, Swanston, Mid-

* *Transactions of the Highland and Agricultural Society*, p. 496 and 532.

† *Ibid.*, July 1844, p. 230.

Lothian, tried the effects of *nitrate of soda* on barley in 1843. The field in which the experiment was tried, at an elevation of 600 feet above the sea, had a southern exposure, and the soil of medium quality, of a depth of 8 or 9 inches, sufficiently free for green crops, but rather having a tendency to clay, with a retentive subsoil. It had been furrow-drained at 18 feet apart. It grew turnips in 1842, manured with farmyard dung, and with a proportion of dairy dung procured from Edinburgh dairymen, the whole crop being carried off the field. Common Scotch barley was sown on 14th April 1843, after the land had received two ploughings, and was reaped on the 1st September. The top-dressing was applied on the 13th May, and benefited by rains immediately after; 1 cwt. 11¼ lb. of nitrate of soda was applied to the acre, at a cost of 22s., and the crop reaped was 60 bushels of 56 lb. to the bushel, and 316 stones of straw. What received no top-dressing yielded 49 bushels of 56 lb. to the bushel, and 212 stones 4 lb. of straw to the acre, affording an increase to the top-dressing of 11 bushels of grain, and 66 stones of straw. The balance stands thus:—

11 bushels of barley at 2s. 9d.,	£2	10	3
104 stones of straw at 2d., . . .	0	17	4

3 7 7

Deduct the value of the manure, . . .

1 2 0

Leaving a profit of . . . £2 5 7½

4927. It is interesting to compare the effects of the cheap ingredient *saltpetre refuse* with the *nitrate of soda*. Mr Main at Whitehill applied it to a soil of moderately strong clay, resting in a retentive subsoil, having an inclination and an exposure to the S.E. The ground was very wet before being drained, and is now quite dry. Since the draining, the soil bears fair crops of turnips and most luxuriant oats and barley, on the latter of which the present experiment was made. The saltpetre refuse was applied on the 27th May 1845, at only 1 cwt. to the acre, to try the effects of a small quantity; at a cost of 10s., and yielded on the 20th September, 61¼ bushels of barley of 50½ lb. to the

‡ *Ibid.*, October 1844, p. 312-13.

bushel, and 495 stones 6 lb. of straw to the acre. What received no top-dressing produced 55 bushels of grain of 51 lb. to the bushel, and 291 stones of straw to the acre. The increase caused by the top-dressing was $6\frac{1}{4}$ bushels of barley, and 204 stones of straw to the acre. The results were these:—

6 $\frac{1}{4}$ bushels of barley at 2s. 9d.,	£0 16 11
204 stones of straw at 2d.,	1 14 0
	<hr/>
	2 10 11
Deduct cost of manure,	0 10 0
	<hr/>
Leaving a profit of	£2 0 11*

The costlier nitrate of soda of Mr Finnie left the larger profit; but the increase by the saltpetre refuse was large in proportion to the cost, and was larger than that from the nitrate of soda, by £1, 13s. 3d. But the nitrate of soda produced grain 56 lb. per bushel, while that from the saltpetre refuse weighed only 50 $\frac{1}{2}$ lb.

4928. The combined effects of a mixture of *nitrate of soda* and *salt* on barley was tried by Mr John Proudfoot, Pinkiehill, Mid-Lothian, on good deep loam, on a gravelly subsoil in very superior order. It had carried wheat in 1842, and the barley experimented on in 1843, so that it was the second white crop in succession. One cwt. each of nitrate of soda and salt, at a cost of 26s., was applied to the acre, and the produce received from them was 62 bushels of barley of 57 lb. to the bushel, and 276 stones of straw. The ground that received no top-dressing yielded 56 bushels of grain of 57 lb. to the bushel, and 256 lb. of straw, showing an increase by the top-dressing of 6 bushels of barley, and 20 stones of straw. The increase is not large either in grain or straw, but the land was in superior order, and could not be expected to be stimulated to an extraordinary degree. The results stood thus:—

6 bushels of barley at 2s. 9d.,	£0 16 6
20 stones of straw at 2d.,	0 3 4
	<hr/>
	0 19 10
Deducting which from the cost of the manures,	1 6 0
	<hr/>
Incurred a loss of	£0 6 2†

4929. Both barley and oats were steeped in different solutions before being sown by Mr Gardner at Barrochan, and the effect was to lessen the yield of grain by at least half a bushel to the acre, while the steeping increased the quantity of straw at the most 80 stones to the acre.

4930. *Oats*.—I shall state the results of guano from oats, before specifying the effects of any of the special manures. Mr Finnie, Swanston, applied 2 cwt. 1 lb. of *guano* to the acre, at a cost of 12s. the cwt. or 24s. an acre, which produced 74 $\frac{1}{2}$ bushels of Blainslie oats, of 42 $\frac{1}{2}$ lbs. to the bushel, and 400 stones of straw. Without the top-dressing, the crop was 48 bushels of oats, at 42 $\frac{1}{2}$ lb. to the bushel, and 223 stones of straw, the increase by the dressing being 26 $\frac{1}{2}$ bushels of oats, and 177 stones of straw. The results are:—

26 $\frac{1}{2}$ bushels of oats, at 2s.,	£2 13 0
177 stones of straw, at 2d.,	1 9. 6
	<hr/>
	4 2 6
Deduct the cost of the manure,	1 4 0
	<hr/>
And the profit is	£2 18 6

The field was elevated 600 feet above the sea, consisting of soil of scarcely medium quality, having a S. exposure, and easily affected by drought. The oats were after pasture, succeeding a crop of barley, immediately preceded by turnips, which had been manured by Edinburgh street manure, and the third part of the turnips eaten off by sheep. The oats were sown on the 20th of March 1843, the guano applied on the 13th of May, rain immediately following, and the crop reaped on the 20th September. †

4931. Mr Charles Chalmers of Monks-hill, applied, on the farm of Rothes Brisbane, in Aberdeenshire, one special manure, *sulphate of ammonia*, on Scots barley oats, on the 18th of May 1843, to the extent of 2 cwt. to the acre, at a cost of £2, 1s. 8d. an acre; and the yield was 81 $\frac{1}{2}$ bushels of oats, of 41 $\frac{1}{4}$ lb. to the bushel, and 473 stones of straw. The ground that received no top-dressing yielded 53 $\frac{3}{4}$ bushels of grain, of 43 lb. to the bushel, and 321 stones of straw, showing

* *Transactions of the Highland and Agricultural Society*, October 1846, p. 407 and 423.

† *Ibid.*, January 1849, p. 434.

‡ *Ibid.*, October 1844, p. 313.

an increase on the top-dressed part of 27 $\frac{3}{4}$ bushels of oats, and 152 stones of straw; but the oats were 1 $\frac{3}{4}$ lb. per bushel lighter. The balance stands thus:—

27 $\frac{3}{4}$ bushels of oats, at 2s.,	£2 15 6
152 stones of straw, at 2d.,	1 5 4
	<hr/>
	4 0 10
Deduct the cost of the manure,	2 1 8
	<hr/>
Leaving a profit of	£1 19 2

The crop was much lodged, which may account for the lightness of the grain. It also constituted a crop of seven years' rotation, which terminated in two consecutive white crops. The field sloped to the S.*

4932. A combination of simple salts was tried on Sandy oats, by Mr A. F. Gardner, at Barrochan, which were the *nitrate of soda* and the *sulphate of soda*, of each 1 $\frac{1}{2}$ cwt. at a cost of 9s. 10d. an acre; and the crop produced was 78 bushels, of 40 lb. to the acre, and 303 stones of straw. The undressed ground gave 61 $\frac{1}{2}$ bushels of grain, and 240 stones of straw, affording an increase of 16 $\frac{1}{2}$ bushels of oats, and 113 stones of straw. The result was:—

16 $\frac{1}{2}$ bushels of oats, at 2s.,	£1 13 0
113 stones of straw, at 2d.,	0 18 10
	<hr/>
	2 11 10
Deduct the cost of the manure,	0 9 10
	<hr/>
Leaving a profit of	£2 2 0

The soil was stiff alluvial loam of good depth, the subsoil of strong yellow clay lying on trap and sandstone. It had been drained nine years, and lain some years in grass, worth £2 the acre. The ground was trenched with the spade in the spring of 1843, 16 inches deep, at a cost of £4 an acre, the turf being laid on the bottom of the trench, and the subsoil brought up to the top. The oats were sown on the 20th of March, top-dressed on the 6th of May, reaped on the 8th September 1843.†

4933. Mr John Dickson, Saughton Mains, Mid-Lothian, tried a combination of *nitrate of soda* and *common salt*, 48 lb. each, at a cost of 18s. 9d. an acre,

as a top-dressing on Early Angus oats, and the produce was 75 $\frac{1}{2}$ bushels of grain, and 80 $\frac{1}{4}$ stones to the acre. The undressed portion of the ground produced 70 $\frac{1}{4}$ bushels of grain, and 608 stones of straw, so that the increase from the top-dressing was 5 $\frac{1}{4}$ bushels of oats, and 196 stones of straw. The result was thus:—

5 $\frac{1}{4}$ bushels of oats, at 2s.,	£0 10 6
196 stones of straw, at 2d.,	1 12 8
	<hr/>
	2 3 2
Deduct cost of the manure,	0 18 9
	<hr/>
Giving a profit of	£1 4 5

The farm is 200 feet above the sea, four miles distant from it, and has a S. exposure. The soil is a light loam on a mixed subsoil, but sufficiently porous to admit of being thoroughly drained, in the autumn of 1839, with stone drains, 30 inches in depth and 32 feet apart. The land bore in 1840, potatoes; in 1841, wheat; in 1842, turnips. The oats were sown on the 20th March, with the drill-machine across the ridges, and top-dressed on the 10th of May 1843.‡

4934. As a change of top-dressing, Mr Proudfoot, Pinkiehill, Mid-Lothian, applied 12 bushels of *bone-dust*, dissolved in 292 lb. of *sulphuric acid*, at a cost of £4, 6s. the acre, on a light soil, resting on a gravelly subsoil, on the 24th April 1843, upon oats after lea, at an elevation not exceeding 100 feet above the sea. The crop yielded was 80 bushels of oats, of 42 lb. to the bushel, and 376 stones of straw to the acre. The undressed part gave 68 bushels of grain, of 43 lb. to the bushel, and 320 stones of straw, affording an increase of 12 bushels of oats, and 56 stones of straw—thus:—

12 bushels of oats, at 2s.,	£1 4 0
56 stones of straw, at 2d.,	0 9 4
	<hr/>
	1 13 4
Deduct cost of the manure,	4 6 0
	<hr/>
Incurring a loss of	£2 12 8s

4935. An instance should be given of the effect of a variety of substances upon the oat crop, and I shall take one from the

* *Transactions of the Highland and Agricultural Society*, July 1845, p. 31.

† *Ibid.*, July 1844, p. 241. ‡ *Ibid.*, January 1845, p. 364-6. § *Ibid.*, January 1849, p. 435.

practice of Mr A. F. Gardner at Barrochan, who applied, on the 20th of May 1845, the following substances:—

	cwt. lb.			
Peruvian guano, . . .	1 0	at	£0 10 0	0
Animal charcoal, . . .	1 0	—	0 4 0	0
Dissolved in sulphuric acid, . . .	0 56	—	0 4 8	
Common salt, . . .	1 0	—	0 1 0	
Silicate of soda, . . .	1 0	—	0 12 0	
Horn dust, . . .	1 0	—	0 2 0	

at a cost of £1 13 8

on black Tartarian oats, on the 10th of April, and obtained $70\frac{3}{4}$ bushels, of $41\frac{1}{4}$ lb. to the bushel, and 376 stones of straw. The part undressed yielded 47 bushels of grain, of 38 lb. to the bushel, and 242 stones of straw, indicating an increase by the dressings of $23\frac{3}{4}$ bushels of oats, and 134 stones of straw. The results are:—

$23\frac{3}{4}$ bushels of oats, at 2s., . . .	£2 13 6
134 stones of straw, at 2d., . . .	1 2 4

3 15 10

Deduct the cost of the manure	1 13 8
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Leaving a profit of £2 2 2

The soil was drained moss, from 8 to 12 feet in depth, resting on a sandy clay bottom. Prior to 1844, it had lain in grass for two years; and in the spring of that year it was trenched with the spade two feet deep, laying the top-spading at the bottom of the trench, and bringing up the peat to the surface. The peat was burned into ashes, which were spread over the surface, and raised a crop of 25 tons to the acre of turnips. The surface was pointed over with the spade in spring, and the oats sown upon it. To supply the want of clay, the silicate of soda was tried, as former experience had found that silicate of potash gave a strong, clear, shining straw on moss-land.*

4936. *Beans*.—Mr A. F. Gardner, at Barrochan, applied 4 cwt. of *gypsum*, at a cost of 6s. an acre, to beans, and reaped $67\frac{1}{2}$ bushels, of 64 lb. to the bushel, and 663 stones of straw to the acre; whereas the ground that received no top-dressing yielded 56 bushels, of 63 lb. to the bushel of grain, and 491 stones of haulm: showing an increase by the dressing of $11\frac{1}{2}$

bushels of beans, and 172 stones of straw. The result is this:—

$11\frac{1}{2}$ bushels of beans, at 3s., . . .	£1 14 6
172 stones of straw, at $2\frac{1}{2}$ d., . . .	1 15 10

3 10 4

Deduct the cost of the manure	0 6 0
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Leaving a profit of £3 4 4

The field had a gentle inclination to the S. It was trenched with the spade 16 inches deep, in the spring of 1842, out of seven years' old lea, which had been drained at 20 feet apart, with tiles, and made perfectly dry. The soil is partly moss and partly sand or gravel loam, which were mixed together in trenching. Besides this, it was dressed with $2\frac{3}{4}$ chaldrons of quicklime, slaked in water that held common salt in solution, in the proportion of 1 cwt. to the chaldron of lime, before the beans were sown on the 6th March 1843. They were top-dressed on the 6th of May, and reaped on the 1st of September.†

4937. Mr Gardner tried to top-dress beans with a variety of special manures, such as,

	cwt. lb.			
Animal charcoal . . .	2 0	at	£0 8 0	0
Dissolved in sulphuric acid, . . .	1 0	..	0 9 4	
Sulphate of magnesia, . . .	0 56	... 0 2 6		
Common salt, . . .	2 0	... 0 2 0		
Nitrate of soda, . . .	1 0	... 0 16 0		

at a cost of £1 17 10

and obtained a crop of $69\frac{3}{4}$ bushels, of $58\frac{3}{4}$ lb. to the bushel, and 629 stones of straw; that which was not top-dressed yielding $58\frac{1}{4}$ bushels, of $58\frac{1}{4}$ lb. to the bushel, and 483 stones of straw: showing an increase, by the application of the top-dressing, of $11\frac{1}{2}$ bushels of beans, and 146 stones of straw. The result is:—

$11\frac{1}{2}$ bushels of beans, at 3s., . . .	£1 14 6
146 stones of straw, at $2\frac{1}{2}$ d., . . .	1 10 5

3 4 11

Deduct the cost of the manure,	1 17 10
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Leaving a profit of £1 7 1

The soil was a stiff loam resting on sandstone; was drained with tiles some years

* *Transactions of the Highland and Agricultural Society*, July 1847, p. 18, 35.

† *Ibid.*, July 1844, p. 242-3.

ago, and has a gentle declivity to the E. It had lain in grass some years; and on being ploughed in spring the beans were sown broadcast, top-dressed on the 21st of May, reaped on the 8th of October, and weighed on the 12th November 1845.*

4938. *Pease*.—Mr John Hannam, North Deighton, Yorkshire, tried the effects of *gypsum* on pease as an auxiliary to farmyard dung. The soil was a thin limestone, worth 16s. the acre, the prior crops being wheat rape-dusted, swedish turnips with manure, and barley with rape-dust. The pease were taken in lieu of clover for a change, and the land for them received 4 loads of farmyard dung to the acre; and the top-dressing of 4 cwt. of gypsum, at a cost of 12s., was spread on the 10th of May 1842, and when reaped yielded $51\frac{1}{2}$ bushels of pease, of 61 lb. to the bushel, and 253 stones of straw; whereas that which received no top-dressing gave $41\frac{3}{4}$ bushels, of 61 lb. to the bushel, and $205\frac{3}{4}$ stones of straw—showing the advantage derived from the top-dressing to be $9\frac{3}{4}$ bushels of pease, and $47\frac{1}{4}$ stones of straw. The results are:—

$9\frac{3}{4}$ bushels of pease, at 3s.,	£1 9 3
$47\frac{1}{4}$ stones of straw, at $2\frac{1}{2}$ d.,	0 9 9
	<hr/>
	1 19 0
Deduct the cost of the manure,	0 12 0
	<hr/>
Leaving a profit of	£1 7 0†

4939. In the same experiment, pease were tried by Mr Hannam with a combination of a half cwt. of *nitrate of soda* and 1 cwt. of the *sulphate of soda*, at a cost of £1, 1s. 3d. an acre; and the produce was $47\frac{3}{4}$ bushels of grain, of 61 lb. to the bushel, and $262\frac{1}{2}$ stones of straw—giving a less satisfactory result than with gypsum alone, by only covering the expense.

4940. *Potatoes*.—Any simple salt, applied as a top-dressing to potatoes, produces but a trifling effect beyond what farmyard dung will always produce; but a combination of special manures, as auxiliaries to farmyard dung, has the effect

of increasing the crop to a sensible degree. By using a combination of such manures, Mr A. F. Gardner, at Barrochan, has been enabled to produce large crops of potatoes. Thus, with

Farmyard dung, 15 tons at 5s.,	£3 15 0
Animal charcoal, 1 cwt.,	0 4 0
Sulphuric acid, 56 lb.	0 7 0
Carbonate of magnesia, 14 lb.	0 1 3
Common salt, 1 cwt.	0 0 9
Gypsum, 1 cwt.	0 1 6
Nitrate of soda, 28 lb.	0 4 0
	<hr/>
at a cost of	£4 13 6

he planted the potatoes on the 29th of April 1844, applied the special manures along with the farmyard dung, and produced, upon very stiff clay loam, on the 7th of October, 20 tons, 3 cwt. 19 lb. on an acre; while 25 tons of farmyard dung, at a cost of £6, 5s., only produced 14 tons, 1 cwt.—giving an advantage of 6 tons, 2 cwt. 19 lb., which, at £2 the ton, is £12, 4s. 4d. an acre in favour of the special manures. The crop itself stands thus:—

20 tons, 3 cwt. 19 lb. of potatoes,	
at £2 per ton,	£40 7 0
Deduct cost of manure,	4 13 6
	<hr/>
Leaving a balance of	£36 13 6†

4941. A coarse variety of the potato, called Connaught cups, afforded Mr Gardner a large return from a combination of manures as auxiliaries to farmyard dung. Thus, with

Farmyard dung, 15 tons at 5s.,	£3 15 0
Animal charcoal, 2 cwt.	0 8 0
Dissolved in sulphuric acid, 1 cwt.	0 9 4
Common salt, 1 cwt.	0 1 0
Sulphate of soda, 1 cwt.	0 5 0
Horn dust, 2 cwt.	0 4 0
Sulphate of magnesia, 1 cwt.	0 5 0
Muriate of ammonia, 1 cwt.	0 15 0
Peruvian guano, 3 cwt.	1 10 0
	<hr/>
at a cost of	£7 12 4

the potatoes were planted on the 5th of May 1845, and, when lifted on the 8th of November, produced 21 tons, 15 cwt.; while 30 tons of farmyard dung, at a cost of £7, 10s., only produced 13 tons, 5 cwt.—giving the above combination an advan-

* *Transactions of the Highland and Agricultural Society*, July 1847, p. 19, 36.

† *Ibid.* March 1844, p. 200-1.

‡ *Ibid.* January 1845, p. 409, Table C.

tage of 8 tons, 10 cwt.; which, at 35s. the ton, being a coarse potato, still gives £14, 17s. 6d. an acre. The field lying on the north side of a hill with a declivity, consisting of a medium soil, has a soil about 16 inches deep, upon a subsoil of great depth of yellow till, full of stones. In 1843 it was drained with tiles, trenched with the spade, and lined with the oats. The special manures were sown broadcast on the dung in the drills.

4942. But independently of farmyard dung, a combination of special manures produced a large return to Mr Gardner of rough red potatoes, which were planted in the same field as the preceding on the 10th of May, and lifted on the 10th of November 1845. The special manures were—

Peruvian guano, 6 cwt. per acre,	£3	0	0
Animal charcoal, 2 cwt.,	0	8	0
Dissolved in sulphuric acid, 1 cwt.,	0	9	4
Horn dust, 3 cwt.,	0	6	0
Muriate of ammonia, 2 cwt.,	1	10	0
Sulphate of soda, 1 cwt.,	0	5	0
Carbonate of magnesia, 1 cwt.,	0	5	0
Common salt, 2 cwt.,	0	2	0

at a cost of £6 5 4

and they produced 20 tons 9 cwt.; while 30 tons of farmyard dung, at a cost of £7, 10s. an acre, only produced, in the same field, 13 tons 1 cwt.—giving the advantage to the special manures of 7 tons 8 cwt., which, at £2 per ton, being a fine potato, is £14, 16s. an acre in favour of the special manures. The case of the crop itself stood thus—

20 tons 9 cwt. of potatoes at £2 =	£40	18	0
Deduct cost of the manures,	6	5	4

Leaving a balance of £34 12 8*

4943. *Carrots*.—Mr Main, at Whitehill, tried to raise carrots with other manure than farmyard dung alone. The soil was light sandy loam, resting on sand and gravel. The inclination of the field was from N.E. to S.W. The field was ploughed from old lea in 1844, and oats taken; in 1845 it was in turnips, manured with farmyard dung, guano, &c; in 1846 it was in oats again; and in 1847 turnips and carrots. In using both farm-

yard dung and special manures, the farm dung was first ploughed in, and pigeons' dung sown broadcast on the surface and harrowed in. On the harrowed surface the carrot seed was sown in rows, in ruts, 14 inches apart, covered with the rake head and trampled down with the feet: 16 tons of farmyard dung were used, at a cost of 5s. a ton, or £4; and 4 cwt. of *pigeon dung*, at 4s. the cwt., or 16s.—in all, £4, 16s. per acre. The produce was 14 tons 5 cwt. 60 lb., and that from 24 tons of farmyard alone, at a cost of 5s. the ton, or £6 an acre, was 12 tons 13 cwt. 64 lb.; so that the increase caused by the pigeons' dung was 1 ton 11 cwt. 108 lb., which, at 30s. the ton, gives a profit, by the special manure, of £2, 7s. 11d. an acre; over and above the value of the 8 tons of dung. The case of the crop itself stands thus—

14 tons 5 cwt. 60 lb. of carrots, } at 30s.,	£21	8	3
Deduct cost of manures, .	4	16	0
Leaving a profit of	£16	12	3†

4944. Mr J. M. Aynesley, Fern Hill, Tockington, raised two varieties of the carrot on clayey loam, a foot in depth, resting on stiff clay—a soil not quite suitable for the carrot. The varieties were the *Alteringham* and the white Belgian. The *Alteringham* was manured with 6 bushels of *common salt*, and 54 bushels of *soot*, at a cost of £2, 2s. 6d. an acre, and produced 22 tons 8 cwt. 64 lb. of carrots; compared with 24 tons of farmyard dung, at 4s. the ton, £4, 16s., which produced 21 tons 18 cwt. 64 lb., giving an advantage of 10 cwt. to the special manures, which, at 30s. the ton, leaves a profit of 15s. per acre. The case of the crop itself is this—

22 tons 8 cwt. 64 lb. carrots, at 30s.,	£33	12	10
Deduct the cost of the manures, .	2	2	6

Leaving a balance of £31 10 4

4945. The *white Belgian* carrot was also manured with 6 bushels of *common salt* and 54 bushels of *soot*, at a cost of £2, 2s. 6d. an acre, and produced 29 tons

* *Transactions of the Highland and Agricultural Society*, July 1847, p. 25 and 27.

† *Ibid.*, March 1849, p. 502 and 533.

8 cwt. 64 lb. an acre; compared with those raised from 24 tons of farmyard dung, which produced 28 tons 8 cwt. 64 lb., giving the advantage to the special manures of just 1 ton on the acre, or 30s. of profit. The crop yielded

29 tons 8 cwt. 64 lb., at 30s.,	£44	2	10
Deduct cost of the manures,	2	2	6
Leaving a balance of	£42	0	4

or £10, 10s. the acre more in favour of the white Belgian than the Alteringham carrot. In both crops the seed was sown on the 19th of April 1842, and pulled from the 4th to the 21st of November.*

4946. Lord Lovelace, in 1843, gave a short account of having raised in several years, but particularly in 1842, 43 tons 36 lb. of red carrots on the acre, with 15 cubic yards of farmyard dung alone. The only peculiarity of the cultures seems to have been the subsoiling to the depth of 15 inches between the drills.

4947. *Swedish turnips*.—The power of guano as an auxiliary to farmyard dung in raising a crop of turnips is considerable. Mr A. F. Gardner, at Barrochan, applied 18 tons of farm dung to the acre at 5s. the ton, £4, 10s., and 3 cwt. of Peruvian guano at 10s. the cwt., £1, 10s.—together making a cost of £6 the acre, produced, in 1844, on stiff clay land that had been trenched with the spade 16 inches deep in the winter of 1842-3, 34 tons 19 cwt. of Swedish turnips; compared with 29 tons 10 cwt., raised with 35 tons of farmyard dung at 5s. the ton, at a cost of £8, 15s. an acre—giving an advantage of 5 tons 9 cwt. to the guano, which, at 10s. the ton, gives a profit of £2, 14s. 6d. an acre. The crop itself stands thus—

34 tons 19 cwt. swedes, at 10s.,	£17	9	6
Deduct cost of the manures,	6	0	0
Leaving a balance of	£11	9	6

whereas the balance left by the farmyard dung alone was £6 the acre. The guano was sown upon the top of the farm dung along the drill on the 13th of May, and

the crop was pulled at the end of October.

4948. In a similar experiment with 20 tons of farm dung, and 6 cwt. of Peruvian guano, sown upon the drills after the crop was up, the produce was 25 tons 3 cwt. 67 lb. of Swedish turnips, while that quantity of dung alone produced only 21 tons 7 cwt. 71 lb.—giving an advantage to the guano of 3 tons 15 cwt. 108 lb., which, at 10s. the cwt., is £1, 18s. 3d. of profit an acre. The crop was sown on the 4th of June, and pulled at the end of October 1844.†

4949. A combination of special manures produced as marked an increase in Swedish turnips as in potatoes. Mr A. F. Gardner, at Barrochan, applied the following special manures on medium loam, after a crop of oats from lea, in 1845:—

Farmyard dung, 15 tons at 5s.,	£3	15	0
Peruvian guano, 3 cwt. at 10s.,	1	10	0
Animal charcoal, 2 cwt. at 4s.,	0	8	0
Dissolved in muriatic acid, 1 cwt.,	0	9	4
Carbonate of magnesia, 1 cwt.,	0	5	0
Sulphate of soda, 1 cwt.,	0	5	0
Sulphate of ammonia, 1 cwt.,	0	16	0
Horn dust, 3 cwt. at 2s.,	0	6	0
Common salt, 1 cwt.,	0	1	0

at a cost of £7 15 4

which produced 46 tons 17 cwt. 6 lb. of Swedish turnips an acre, of value £23, 8s. 6d., at 10s. the ton; compared with 30 tons of farmyard dung at 5s., £8, 15s., which produced 34 tons 5 cwt. 80 lb., giving the advantage of 12 tons 11 cwt. 38 lb. to the special manures, amounting to £6, 5s. 8d. an acre, at 10s. the ton. The value of the crop itself stands thus—

46 tons 17 cwt. 6 lb. Swedes at 10s.	£23	8	6
Deduct the cost of the manures,	8	15	0

Leaving a balance of £14 13 6‡

4950. With 15 cubic yards of farmyard dung, at 5s. the yard, £3, 15s.; 4 cwt. of Peruvian guano, at 10s. the cwt., £2; and 17 bushels of bone-dust, at 2s. 6d. the bushel, £2, 2s. 6d., Mr Robert Elliot, Hardgrave, Dumfriesshire, raised 28 tons 9 cwt. of Swedish turnips an acre, in

* *Journal of the English Agricultural Society*, vol. iv. p. 270.

† *Transactions of the Highland and Agricultural Society*, March 1845, Table G.

‡ *Ibid.*, July 1847, p. 29.

1849, at a cost of £7, 17s. 6d., the value of the crop, at 10s. the ton, being £14, 4s. 6d., leaving a balance, after deducting the cost of the manures, of £6, 7s. an acre, and making the cost of a ton of Swedes only 5s. 6d.*

4951. *Yellow turnips*.—Mr John Finnie, Swanston, tried single special manures as auxiliaries to farmyard dung, on a soil of rather good quality, having a retentive subsoil, at a depth of 12 or 13 inches. The field is exposed to the N., was under wheat in 1842, preceded by potatoes, raised with farm dung and Edinburgh street manure in equal proportions. Skirving's purple top yellow turnips were sown on the 15th of June, the special manure sown over 16 tons of dung, at 5s. the ton, £4, spread along the drill, and the turnips were pulled on the 1st of November 1843. Thus, 12 tons of dung at 5s., £3, and 1 cwt. 67 lb. of ammoniacal salts, at 20s. the cwt., £1, 12s., together making a cost of £4, 12s. an acre, produced 33 tons, 6 cwt. 13 lb; and which, compared with the produce of 16 tons of dung at 5s., £4, 25 tons 4 cwt., gives an advantage to the special manure of 8 tons 2 cwt. 13 lb. at 8s. the ton, of £3, 4s. 9d. an acre, over and above the value of 4 tons of dung. The value of the crop stands thus—

33 tons 6 cwt. 13 lb. yellow turnips, at 8s.,	£13 6 6
Deduct the cost of the manures,	4 12 0
Leaving a balance of	£8 14 6†

4952. It may be mentioned here, that ammoniacal liquor, obtained from the gas-works, is of greater or less value as it is obtained from the particular kind of coal the gas is extracted from. The purer the coal the gas is derived from, such as the cannel coal, used at Edinburgh, the ammoniacal liquor is less rich in useful ingredients than from coal of a more bituminous character. Hence the ammoniacal liquor of Newcastle or London is better than that of Edinburgh.

4953. Mr A. F. Gardner, at Barrochan, tried the effects of a combination of special manures on Jones' yellow turnip, as

well as on the Swede, and with similar good results. The manures were these—

Farmyard dung, 15 tons at 5s.,	£3 15 0
Peruvian guano, 3 cwt. at 10s.,	1 10 0
Animal charcoal, 2 cwt. at 4s.,	0 8 0
Dissolved in sulphuric acid, 1 cwt.,	0 9 4
Carbonate of magnesia, 1 cwt.,	0 5 0
Sulphate of soda, 1 cwt.,	0 5 0
Muriate of ammonia, 1 cwt.,	0 15 0
Common salt, 1 cwt.,	0 1 0
Potash, 28 lb., at 28s. the cwt.,	0 6 6
Horn dust, 2 cwt. at 2s.,	0 4 0

at a cost of £7 18 10

and the produce was 42 tons, 17 cwt. 10 lb. Compared with 31 tons obtained from 30 tons of farmyard dung, at 5s. the ton, at a cost of £7, 10s. an acre, the advantage accruing by the use of the special manures was 11 tons 17 cwt. 10 lb., at 8s. the ton, amounts to £4, 15s. 1d. The value of the crop itself is this—

42 tons 17 cwt. 10 lb. Jones' yellow, at 8s.,	£17 3 1
Deduct the cost of the manures,	7 18 10

Leaves a balance of £9 4 3‡

4954. On the farm of Balgray, in the parish of Applegarth, Dumfriesshire, 29 tons 3 cwt. per acre of yellow bullock turnips were raised by 35 cubic yards of farmyard dung, at a cost, at 5s. the yard, of £8, 15s. an acre. The cost of raising the turnips was thus 6s. 4d. the ton.§

4955. *White turnips*.—Mr John Hannam, North Deighton, Yorkshire, tried experiments with special manures both as substitutes for and as auxiliaries to farmyard dung. The best substitute was *burnt bones*, 2 quarters of which an acre, at a cost of £2, 1s., produced 25 tons 17 cwt. 1 lb. of Matson's white-globe turnips, of 243 good turnips to each perch; while the ground that had none produced only 16 tons 1 cwt. of small bulbs—the advantage obtained by the bones being 9 tons 16 cwt. 1 lb., at 6s. the ton, £2, 18s. 9d. an acre. As an auxiliary to farmyard dung, 12 bushels of *bone-dust* and 6 bushels of *rape-cake dust* to the acre, at a cost of £2, 6s. 9d. produced 26 tons 15 cwt. 5 lb., of 228 turnips to the perch, and secured an advantage of 10 tons 14 cwt. 5 lb., at 6s. the ton, £3,

* *Transactions of the Highland and Agricultural Society*, March 1850, p. 237.

† *Ibid.*, October 1844, p. 316.

‡ *Ibid.*, July 1847, p. 31.

§ *Ibid.*, March 1850, p. 238.

4s. 2d. an acre. The crop itself stands thus in value:—

26 tons 15 cwt. 5 lb. globes, at 6s.	£8 0 6
Deduct the cost of the manure,	2 6 9
Leaving a balance of	£5 13 9

The soil moderate limestone, worth 24s. per acre, exposed on all sides. Former crops—grass pastured with sheep, wheat rape-dusted, and oats rape-dusted. The turnips were drilled on the level on the 4th of July, at 12 inches apart, and pulled on the 5th of November 1842.*

4956. These special manures,—

Farmyard dung, 15 tons at 5s.,	£3 15 0
Peruvian guano, 3 cwt. at 10s.,	1 10 0
Animal charcoal, 2 cwt. at 4s.	0 8 0
Dissolved in muriatic acid, 1 cwt.,	0 9 4
Horn dust, 2 cwt. at 2s.,	0 4 0
Common salt, 2 cwt. at 1s.,	0 2 0
at a cost of	£6 8 4

produced 34 tons 11 cwt. 48 lb. of purple-top white turnips. Compare this with the produce of 30 tons of farmyard dung at 5s. the ton, at a cost of £7 10s., 33 tons 14 cwt. 32 lb., and the special manures have only an advantage of 17 cwt. 16 lb. an acre, which at 6s. the ton is worth 5s. 1d. The value of the crop itself is this:—

34 tons 11 cwt. 48 lb. white, at 6s.,	£11 7 4
Deduct the cost of the manure,	6 8 4
Leaving a balance of	£4 19 0

The soil was medium loam. The preceding crop was oats on trenched lea. The special manures were sown upon the dung in the drills, on the 26th June, and the turnips pulled on the 12th of November 1845.†

4957. *Hybrid turnips*—Mr Thomas L. Colbeck, East Denton, Newcastle-on-Tyne, applied *alkaline phosphates* with *ammonia*, the phosphates being prepared by dissolving bones in an excess of sulphuric acid, and neutralising by means of an alkali; 4 cwt. of which at 8s. 3d. the cwt. at a cost of £1, 13s. an acre, produced 37 tons 8 cwt. of hybrid turnips, making the cost of the crop 10d. per ton.

4958. This special manure was composed of—

Organic matter,	16.3
Inorganic matter,	63.9
Water,	19.8
	100.0

To compare with this, 20 tons of farmyard dung, fermented until it could be cut with a spade, were applied to the acre, at a cost of £5, and it produced 31 tons of turnips, giving an advantage to the special manure of 6 tons 8 cwt., which, at 6s. the ton, realises a profit of £1, 18s. an acre. The value of the turnips was 3s. 2d. the ton. This manure consisted of—

Organic matter,	24.71
Inorganic matter,	10.06
Water,	64.96
	99.73

4959. Some curious anomalies were obtained by the use of these alkaline phosphates. We have seen that 4 cwt. of them produced 37 tons 8 cwt. of turnips; but when an addition of 10 tons of farmyard dung was made to that quantity of the phosphates, the produce shrunk to 26 tons the acre, making the value of the turnip 3s. 2d. the ton: 26 tons were also produced by 8 cwt. of the alkaline phosphates alone, which made the value of the turnips 2s. 10d. the ton. But when 10 tons of farmyard manure were added to 8 cwt. of the alkaline phosphates, the produce was increased to 31 tons—the same amount as from 20 tons of farmyard dung alone. The value of the turnips, from the dung alone, was 3s. 2d. the ton, but the dung and phosphates combined, increased their value to 4s. Hence we should conclude, that alkaline phosphates and farmyard dung should not be combined, but applied separately. In like manner earthy sulphates, prepared by dissolving magnesian limestone in sulphuric acid, and 20 tons of farmyard dung, each separately, produce 31 tons of turnips; but when combined, the produce falls to 26 tons, and increases the value of the turnips to 4s. 1d. the ton. The sulphates are composed of—

Inorganic matter,	86.9
Water,	12.7
	99.6

* *Transactions of the Highland and Agricultural Society, March 1844, p. 171.*

† *Ibid.*, July 1847, p. 33.

and they alone make the value of the turnips only 1s. 9d. the ton.

4960. The turnips were sown in May and pulled in December 1847—the four preceding crops being, in 1843, turnips manured with farmyard dung; in 1844, barley; in 1845, pease instead of clover; in 1846, oats. The soil is formed from the disintegration of the upper red conglomerate of the coal series. The neighbourhood is principally formed from the clay slate of the same series. It is consequently a strong wheat soil, worth 40s. the acre, and is considered a tolerably good turnip soil. It does not grow a fine sample of wheat, and is not yet dry enough beneath for turnips, to be eaten off with sheep in winter. It is sufficiently dry for ordinary cultivation without furrow drainage, the outburst of water having been taken off by cross drains.*

4961. *Mangold-wurzel*.—This is a root but scantily grown in Scotland, and the source of our information regarding its produce must be derived from the experience of English cultivators. On light land, being in part a shifting sand, Mr Pusey of Pusey, in Berkshire, associated special manures with 13 loads of farmyard dung; and although Mr Pusey does not give prices at all, I shall estimate the various manures at the usual cost, and say that the dung was worth 5s. the load, at a cost of £3, 5s. an acre; 7 cwt. of rags at 4s. the cwt., at a cost of £1, 8s. an acre; and 3 cwt. of guano at 10s. the cwt., at a cost of £1, 10s. an acre, each of which produced 36 tons of mangold-wurzel an acre, making the value of the crop 2s. 7d. per ton. With 26 and 13 loads of farmyard dung an acre, 28½ and 27½ tons of mangold-wurzel were produced respectively; and with no manure at all, 15½ tons an acre were obtained—so that the special manures secured an advantage of 8 tons over the farmyard manure, and 20½ tons over what received no manure. Estimating mangold-wurzel at the same price as swedes, 10s. the ton, the pecuniary advantage over the produce from the farmyard dung is £4, and over that from the ordinary state of the soil, £10, 5s. an

acre. The value of the crop itself is this:

36 tons of mangold-wurzel, at 10s.,	£18 0 0
Deduct the cost of the manure,	4 15 0
Leaving a balance of	£13 5 0†

4962. Lord Lovelace raised, at Oakham Park, large crops of long red mangold-wurzel—in 1831, as much as 58 tons 8 cwt. 60 lb. an acre; and on an average of 12 years from 1831 to 1842, both inclusive, the quantity was 47 tons, 19 cwt. 59 lb. the acre. In 1841 and 1842 he raised 42 tons 3 cwt., and 43 tons 2 cwt. of the orange globe variety to the acre. As the cultivation is peculiar, I shall relate it in his lordship's own words. In autumn, the stubble is manured with 15 cubic yards of farmyard dung and ploughed down. "In April the ground is ridged at a width of 3 feet, by a double mould-board going out and returning in the same furrow. The subsoil plough follows immediately along the furrow, and stirs the ground 15 inches deeper; and the remaining 15 cubic yards allotted to each acre, in all 30 cubic yards, are put in the trench and covered in the usual manner. The mangold is sown on the newly formed ridge with the turnip-drill, about the end of April or beginning of May. Three or four weeks afterwards the furrows are subsoiled, (so that the field is thoroughly stirred) and the plants are left to stand at intervals (in the lines) of 14 to 18 inches, the lines being 3 feet apart. I will only add one word more about the second subsoiling. After the plants have come up, and are five or six weeks old, if you examine them you will find that even then their fibres are nearly meeting; the subsoiling in the intervening furrow then heaves up the ridges on which they are growing, and they seem to float upon the soil: directly afterwards, I suppose, they dive down in quest of further nourishment. The plants grow so rapidly as to take entire possession of the soil, and the shade of the leaves prevents the growth of weeds; consequently no hoeing is requisite after they have been once thinned out to their proper distance. They are taken up in November, and have

* *Transactions of the Highland and Agricultural Society*, January 1850, p. 141-62.

† *Journal of the English Agricultural Society*, vol. vi. p. 530.

been kept till June, or even July, with care." *

4963. *Tares*.—Mr John Finnie, Swanston, applied 1 cwt. $22\frac{1}{2}$ lb., of *ammoniacal salts*, at a cost of £1, 3s. 11d. an acre, and obtained a cutting of 1143 stones. The ground that had not been top-dressed yielded 967 stones, so that the top-dressing gave an increase of 176 stones, which at $1\frac{1}{4}$ d. the stone is 18s. 4d., incurring a loss of 5s. 7d. an acre. The crop itself stands thus :—

1143 stones of tares, at $1\frac{1}{4}$ d. per stone,	£5 18 11
Deduct the cost of the manure,	1 3 11

Leaving a profit of	£4 15 0
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The field was exposed to the S., and consisted of very light soil incumbent on greenstone. In 1841 it was under turnips, manured with rich farmyard dung and Edinburgh street manure; and the third part of the crop was eaten on the ground with sheep. In 1842 barley succeeded the turnips, and was sown down with grass seed. In 1843, the grass seeds not succeeding, they were ploughed up on the 29th of March, and the tares sown on the 1st of April following, with a mixture of four parts of tares to one of oats. The top-dressings were applied on the 12th of May, and the tares mown on the 10th of August.†

4964. Mr James Melvin, Bonnington, Mid-Lothian, sowed beans and tares together in 1843, with 16 tons to the acre of farmyard dung, and top-dressed the ground afterwards with 1 cwt of *sulphate of soda*, and 56 lb. of *nitrate of soda*, at a cost of 13s. 9d. an acre, and the produce was 1760 stones. The part that received farmyard dung alone produced 1632 stones, giving an advantage to the top-dressing of 128 stones an acre, which at $1\frac{1}{4}$ d. the stone is 13s. 4d., about the same amount as the extra cost of the special manures. The crop itself stands thus :—

1760 stones of tares, at $1\frac{1}{4}$ d. per stone,	£9 3 4
Deduct the cost of the manures,	0 13 9

Leaving a balance of	£8 9 7+
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4965. *Hay of clover and rye grass*.—

Mr John Finnie, Swanston, applied 1 cwt. 11 lb. of *nitrate of soda*, at a cost of 22s. an acre on the 13th of May 1843. The grass was cut on the 10th, and weighed on the 15th July, at 344 stones an acre; while that which was not top-dressed only yielded 181 stones—giving an advantage to the top-dressing of 163 stones, which, at 6d. the stone, for half-made hay that year, was £4, 1s. 6d., leaving a profit of £2, 19s. 6d. an acre. The crop itself stood thus :—

344 stones of clover hay, at 6d. the stone,	£17 4 0
Deduct the cost of the manure,	1 2 0
Leaving a balance of	£16 2 0

The field was exposed to the S. and the soil was eight or nine inches in depth, easily pulverised, but having a slight mixture of clay, and resting on a retentive subsoil.‡

4966. Mr James McLean, Braidwood, top-dressed clover and rye-grass with 3 cwt. 4 lb. of *guano*, at a cost of £3, 18s. 7d. an acre, on the 7th of May 1842; the grass was cut on the 24th of June, and the hay weighed and stacked on the 5th of July, the produce being 398 $\frac{1}{2}$ stones. The ground that was not top-dressed yielded 125 stones, so that the top-dressing procured the great increase of 273 $\frac{1}{2}$ stones an acre, which, at 7d. the stone, gives £7, 19s. 6d. an acre, and a profit of £4, 0s. 11d., after deducting the cost of the manure. The crop itself stands thus :—

398 $\frac{1}{2}$ stones hay, at 7d the stone,	£12 12 5
Deduct the cost of the manure,	3 18 7
Leaving a balance of	£8 13 10 1

4967. Mr A. F. Gardner, at Barrochan, applied the following special manures :—

Animal charcoal, 1 cwt.	£0 4 0
Dissolved in sulphuric acid, 56 lb. at 9s. 4d. cwt.	0 4 8
Horn dust, $1\frac{1}{2}$ cwt. at 2s.,	0 3 0
Carbonate of magnesia, 14 lb. at 5s. 4d. per cwt.	0 0 8
Sulphate of soda, 28 lb. at 5s. per cwt.,	0 1 3
Common salt, 56 lb. at 1s. per cwt.,	0 0 6
Sulphate of ammonia, 28 lb. at 16s. cwt.,	0 4 0
Potash, 28 lb. at 24s. per cwt.,	0 6 0
Carbonate of soda, 28 lb. at 8s. per cwt.,	0 2 0

at a cost of	£1 6 1
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* *Journal of the English Agricultural Society*, vol. iv. p. 21.

† *Transactions of the Highland and Agricultural Society*, October 1844, p. 314-5.

‡ *Ibid.*, January 1849, p. 439. § *Ibid.*, October 1844, p. 314-17. ¶ *Ibid.*, July 1843, p. 30.

This mixture produced 931 stones 4 lb., while the ground that received no top-dressing only produced 331 stones 12 lb., giving a balance in favour of the top-dressing of 599 stones, which at 4½d. the stone, or £3 the ton, are worth £11, 4s. 7d. an acre, and, after deducting the cost of the manures, leave a profit of £9, 13s. 10½d. an acre. The crop itself stands thus:—

931 stones hay, at 4½d. the stone,	£17 9 1
Deduct the cost of the manures,	1 6 1
Leaving a balance of	£16 3 0

The soil was medium loam. It was cropped in 1843 with potatoes, and in 1844 with barley sown down with grass seeds. The grass was top-dressed on the 28th of April, cut down on the 26th of June, and the hay stacked on the 28th of August, 1845.*

4968. *Hay of ten years old lea.*—Mr Gardner made experiments of top-dressings of special manures on old lea, varying in age from 3, 6, 10, 15, to 30 years, the results of which are all instructive, but I shall confine myself to two of the most successful instances. In 1843 he top-dressed 10 year old lea with half a hundredweight of *nitrate of soda*, at a cost of 8s. 9d. an acre, and obtained 533½ stones of hay; while that which received no top-dressing yielded 401 stones, giving the special manure an advantage of 132½ stones to the acre, at 6d. the stone, £3, 6s. 3d.; and after deducting the cost of the manure, 8s. 9d., left a profit of £2, 17s. 6d. an acre. The crop itself stood thus:—

533½ stones of hay, at 6d. the stone,	£13 6 9
Deduct the cost of the manure,	0 8 9
Leaving a balance of	£12 18 0

The crop yielded 325 lb. of hay from every 1000 lb. of the grass cut green.†

4969. On *eleven years old lea*, Mr Gardner applied these special manures as a top-dressing on the 23d of April 1844:—

Peruvian guano, 1½ cwt. at 10s. the cwt.,	£0 15 0
Animal charcoal, 1 cwt.,	0 4 0
Muriate of ammonia, 56 lb. at 16s. the cwt.,	0 8 0
Common salt, 56 lb. at 9d. the cwt.,	0 0 4½
Gypsum, 1 cwt.,	0 1 6
at a cost of	£1 8 10½

The grass was cut on the 12th of July, and the hay stacked and weighed on the 15th of August, at 497 stones an acre, while the undressed part only yielded 228 stones, giving an advantage of 269 stones to the manures, at 4½d. the stone, £5, 0s. 10d. an acre, and, after deducting their cost, leaving a profit of £3, 11s. 11½d. an acre. The crop itself stands thus:—

497 stones hay, at 4½d. the stone,	£9 6 4½
Deduct the cost of the manures,	1 8 10½
Leaving a balance of	£7 17 6½

4970. *Rye-grass seed.* Mr Charles Stevenson, Redside, East Lothian, top-dressed the second year's rye-grass for seed, growing on red clay resting on stiff clay. The farm is three miles from the sea, and elevated about 100 feet above it, and the exposure of this particular field was partly N. and partly S. It was furrow drained in 1837 at 36 feet apart, with tiles and stones placed above them. The preceding crops were in 1838 bare fallow; 1839, wheat; 1840, turnips; 1841, barley; 1842, hay; and in 1843, rye-grass for seed. The top-dressing, *nitrate of soda*, 1 cwt. 67 lb., at a cost of £1, 15s. 3d. an acre, was applied on the 7th of April, the grass cut in July, and the hay weighed when maturely won, at 320 stones, while the part undressed only yielded 174 stones, giving an advantage to the top-dressing of 146 stones an acre. Taking the price of hay at £3 the ton, or 4½d. the stone, the advantage was £2, 14s. 11d., and after deducting the cost of the manure, the profit was 19s. 8d. an acre; but the crop was worth more as one of rye-grass seed, the quantity not being mentioned by Mr Stevenson. The crop itself, as hay, stands thus:—

320 stones hay, at 4½d the stone,	£6 0 0
Deduct the cost of the manure,	1 15 3
Leaving a balance of	£4 4 9§

4971. These are the largest returns, from the respective crops enumerated, I can find recorded; and it might have proved interesting and instructive, by way of comparison, had I given the smallest returns also, and which I would willingly have done had space been avail-

* *Transactions of the Highland and Agricultural Society*, July 1847, p. 20.

† *Ibid.*, July 1844, p. 240.

‡ *Ibid.*, March 1845, Table B.

§ *Ibid.*, October 1844, p. 334.

able. It would tend to no good result to draw general conclusions from the few cases that have been adduced; but the effects of certain classes of special manures are so obvious, upon every species of crop they were applied to, that no harm can accrue from noticing them. It seems, then, that all special manures containing a large proportion of nitrogen, such as rape-cake, sulphate of ammonia, muriate of ammonia, nitrate of soda, and suchlike, reduce the weight of the grain they produce, while they increase the quantity of both grain and straw; whereas chlorides, sulphates, soda, magnesia, bone-dust, and the like, increase the weight but deteriorate the quality of the grain in comparison with ordinary farmyard manure.

4972. It may prove useful to give a list of the chemical and commercial names and current price of the various sorts of manures recommended for use. It is useless to specify the quantity to be applied of each to the acre, as experience has not yet determined the point with certainty; and it is equally unsatisfactory to state the quantities used by every experimenter on every kind of crop, since the ingredients were only used experimentally, and such quantities cannot therefore prove a correct guide for others to follow, and might rather have a tendency to mislead. The best results hitherto obtained are the only safe ones the attention can be directed to; and cases of failure would perhaps have been equally instructive: but few of these are recorded with the same degree of candour as the instances of comparative success. A long time must elapse ere certainty can be attained in a matter admitting of such a variety of quantities, and in the mean time every farmer must experiment for himself in his own peculiar circumstances. The time will no doubt arrive when a large accumulation of facts will indicate the substances most to be relied on, and all others will be rejected; and then the young farmer will reap the advantages secured to him by the experience of his experimenting predecessors.

4973. That a long time must elapse, ere the special manures can inspire the same confidence in their effects as is already placed in those of farmyard dung, bone-dust, and Peruvian guano, will appear from the following considerations:—the influence of the varying quality of farmyard dung on the results of comparative experiments, in which it is one of the ingredients employed; the previous treatment of the land; one ingredient counteracting the action of another; the time, manner, and form of the application of the ingredients; the physical condition of an ingredient, its state of chemical action, and its tendency to decompose in a given soil; and the different varieties of seed causing discordances in

the observed effects of different manures; and the influence of the seasons. What renders results still less available is, that "the careful sifter of experiments," as Professor Johnston well observes, "must bear all such things in mind in comparing results, and in attempting to reconcile such as differ, or to extract general rules and principles from such as agree. The maker of experiments, also, must neither be surprised nor discouraged if a series of trials which has cost him thought, trouble, and expense, should, by the chances of one unusual season, by the unsuspected condition of his land, or by other accidents, be rendered wholly abortive. Such accidents form one of those numerous sources of delay to which the progress of scientific agriculture is peculiarly liable, which have made its advance so slow, many of its steps in advance so doubtful and insecure, and have disheartened and driven from its service many useful and talented men."* To my view, the prospect of using the special manures as they ought and might be used, is very distant indeed.

4974. I am not sure that the following substances as manures comprehend the entire number presented to the notice of the farmer. The prices in 1850, I have endeavoured to obtain as correctly as possible from authentic sources.

SALINE MANURES.

Agricultural salt,	<i>Sol'd rock-salt.</i>	1s. cwt.
Carbonate of ammonia,	<i>Sal volatile,</i>	50s. to 56s. cwt.
Carbonate of magnesia,	..	50s. cwt.
Carbonate of potash,	<i>American potash,</i>	28s. to 42s. cwt.
.. soda,	<i>Soda crystals,</i>	8s. cwt.
Chloride of sodium,	<i>Common salt,</i>	1s. 3d. cwt.
Muriate of ammonia,	<i>Crystals,</i>	28s. cwt.
Muriate of potash,	..	13s. cwt.
Nitrate of potash,	<i>Nitre, Saltpetre,</i>	29s. to 30s. cwt.
.. soda,	..	16s. cwt.
Silicate of potash,	..	L.6 to L.8 ton.
Sulphate of ammonia,	..	15s. to 18s. cwt.
Sulphate of lime,	<i>Gypsum,</i>	2s. cwt.
.. magnesia,	<i>Epsom salts,</i>	8s. to 10s. cwt.
.. potash,	..	12s. to 14s. cwt.
.. soda,	<i>Dry salts,</i>	4s. to 6s. cwt.
Phosphate of ammonia,	..	50s. cwt.
Phosphate of soda,	..	25s. cwt.

CALCINED MANURES.

Soda ash,	<i>Refined kelp,</i>	L.11 to L.12 ton.
Kelp salt,	..	4s. to 5s. cwt.
Clay ashes,	<i>Burnt clay,</i>	2d. bushel.
Coal ashes,	.. coal,	2s. 6d. ton.
Dutch ashes,	.. peaty soil,	£3 ton.
Peat ashes,	.. peats,	2d. bushel.
Turf ashes,	.. sods,	5d. ..
Wood ashes,	.. wood,	6d. ..
Kelp,	.. sea-weed,	5s. to 6s. cwt.
Charred peat,	<i>Peat charcoal,</i>	40s. ton.
.. sawdust,	..	nominal.
Burnt bones,	<i>Bone black,</i>	20s. qr.

MINERAL ACID MANURES.

Sulphuric acid,	<i>Oil of vitriol,</i>	3d. lb.
Muriatic acid,	<i>Spirits of salts,</i>	1d. lb.

NATURAL MANURES.

Peruvian guano,	..	L.9 to L.10 ton.
Ichaboe guano,	<i>African,</i>	L.8, 10s. ton.
Patagonian guano,	..	L.5, 10s. to L.6 ton.

* Johnston's *Experimental Agriculture*, p. 71-2.

Saldanha Bay guano,	<i>African,</i>	L.5 to L.5, 10s. ton.
Pigeon dung,	..	L.4 ton.
Poultry dung,	..	L.4 ton.
Cow dung,	..	5s. ton.
Urine,	<i>Chamber lye,</i>	5d. gallon.
Cow urine,	<i>Cow wash,</i>	4½ to 6d. butt.
Nightsoil,	<i>Dung,</i>	4s. cwt.
Dry nightsoil,	<i>Dried dung,</i>	40s. to 50s. hhd.
Fish offal,	<i>Fish compost,</i>	2s. ton.
Animal offal,	<i>Shambles' refuse,</i>	6s. ton.
Bone-dust,	<i>Ground bones,</i>	18s. 6d. to 20s. qr.
Bone sawdust,	<i>Bone powder,</i>	L.6 to L.7 ton.
Soot,	..	3d. to 9d. bushel.
Phosphorite,	<i>Coprolites,</i>	4s. 8d. cwt.

MANUFACTURED MANURES.

Turnbull's guano,	..	8s. cwt.
Potter's guano,	..	L.15 ton.
British guano,	..	L.11 to L.12 ton.
Clark's desiccated } compost,	..	73s. hhd.
Dalton's manure A,	..	12s. cwt.
Dalton's manure B,	..	15s. cwt.
Poittevin's desiccated } compost,	..	13s. cwt.
Watson's compost,	..	18s. cwt.
Ryan's azotized ma- } nure,	..	{ L.5, 10s. to L.6, 10s. ton.
Liebig's manure,	..	L.10 ton.
Lawe's manures,	..	L.7 to L.12 ton.
Daniell's manure,	..	8s. qr.
Lance's carbon,	..	12s. qr.
.. humus,	..	L.4 ton.
Turnbull's humus,	..	4s. cwt.
.. prepared } bones,	..	4s. cwt.
Nesbitt's manures,	..	L.7 to L.14 ton.
Spence's prepared } bone manure,	..	L.8 ton.
Superphosphate of } lime,	<i>Sulphated bones,</i>	L.6, 10s. to L.8 ton.
Urate,	<i>Dry sewerage,</i>	84s. hhd.
Animalised carbon,	<i>Animal black,</i>	3s. cwt.
Ditto dissolved in } sulphuric acid,	..	9s. cwt.
Nightsoil prepared } with shells,	..	4s. cwt.
Nightsoil prepared } with gypsum,	..	4s. cwt.
Wheat manure,	..	L.8, 10s. to L.9 ton.
Animal charcoal,	..	6s. to 6s. 6d. cwt.

REFUSE MANURES.

Whale oil refuse,	<i>Whale blubber,</i>	5s. to 7s. ton.
Seal oil refuse,	<i>Seal blubber,</i>	5s. to 7s. ton.
Rape oil refuse.	{ <i>Rape cake,</i> <i>Rape dust,</i>	L.5 to L.5, 10s. ton. L.5, 10s. to L.6 ton.
Pollards,	<i>Fine bran,</i>	4s. 6d. cwt.
Sugar refuse,	..	20s. to 40s. ton.
Horn dust,	..	2s. cwt.
Saltpetre refuse,	<i>Gunpowder refuse,</i>	12s. ton.
Ammoniacal liquor,	<i>Gas water,</i>	1d. gallon.
Sulphuric urine,	<i>Sulphated wash,</i>	16s. cwt.
Chloride of lime,	<i>Bleacher's refuse,</i>	28s. cwt.
Soap ashes,	<i>Soap-boiler's refuse,</i>	10s. ton.
Coal tar,	..	¼d. gallon.
Gas lime,	..	7s. 6d. chaldron.
Rag lye,	..	1s. 25d. gallons.
Woolen rags,	..	L.4 to L.4, 10s. ton.
Shoddy,	..	20s. ton.
Croppings,	..	nominal.
Singeing dust,	..	nominal.
Flax waste,	..	nominal.
Tanner's bark,	<i>Waste bark,</i>	6d. ton.

4975. In the nomenclature of the substances enumerated in the first section of the above list, it will be observed that they assume a strictly chemical character; but they are not entitled to such a distinction, as the salts sold to the farmers for the purposes of manure are not the pure neutral salts which their names indicate, but salts in a crude state, containing impurities of manufacture. The pure salts of those names would be far too expensive for farmers to employ. The cruder ones, being much cheaper, are

sufficiently pure to answer the purpose of a manure; but in order to test their value, farmers on purchasing them, should demand from the sellers a guarantee of the quantity of alkali and of acid that they contain; and by comparing this with a list of the composition of the salts in a crude state, before the practical chemist purifies them for the apothecaries, it will be ascertained whether the articles purchased are genuine or otherwise. These ingredients are generally procured from the drysalter, and not from the manufacturers, who desire to deal with purchasers on a much larger scale than farmers are likely to be.

4976. The percentage of the alkalis and acids which enter into the composition of the chief chemical substances in the foregoing list, as articles of commerce, is as follows, and was kindly furnished to me by Mr Tennant, of the Bonnington Chemical Works, Edinburgh. The deficiency in the percentage of some of the numbers consist of water; others are nearly pure, while most contain impurities.

		Percentage of impurity.
Carbonate of ammonia,	44.09 { ammonia, 55.91 { carbonic acid.	} 20
.. magnesia,	41.60 { magnesia, 36.58 { carbonic acid.	
.. potash,	60 per cent of { potash, with variable proportions of carbonic, sulphuric, and silicic acids, besides sulphur.	}
<i>American potash,</i>		
.. potash,	55.00 { potash, carbonic acid, with sulphate and silicate of potash and impurities.	}
<i>Pearl ashes,</i>	25.21	
.. soda,	21.81 { soda, 15.43 { carbonic acid.	} 3
Chloride of sodium,	39.66 { soda, 60.34 { chlorine.	
Muriate of ammonia,	33.89 { ammonia, 66.11 { muriatic acid.	} 2
.. potash,	52.53 { potassium, 47.47 { chlorine.	
Nitrate of ammonia,	29.29 { ammonia, 60.64 { nitric acid.	} 5
.. potash,	46.56 { potash, 53.44 { nitric acid.	
.. soda,	36.60 { soda, 63.40 { nitric acid.	} 5
Phosphate of ammonia,	42.29 { ammonia, 57.71 { phosphoric acid.	
.. lime,	44.38 { lime, 55.62 { phosphoric acid,	} 5
.. soda,	17.88 { soda, 20.40 { phosphoric acid.	
Silicate of potash,	50.54 { potash, 49.46 { silicic acid.	} 70
Sulphate of ammonia,	39.48 { ammonia, 60.52 { sulphuric acid.	
.. lime,	32.90 { lime, 46.31 { sulphuric acid.	} 5
.. magnesia,	16.70 { magnesia, 32.40 { sulphuric acid.	
.. potash,	34.07 { potash, 45.93 { sulphuric acid.	} 40
.. soda,	43.82 { soda, 56.18 { sulphuric acid.	
Soda ash,	48 per cent of soda.	}
Kelp salt,	10 to 30 per cent of carbonate of soda.	

4977. The weight of some of these manures by the bushel is as follows:—

	Per bushel lb.	to	lb.
Agricultural salt,	70	to	80
Bone-dust,	42	..	44
Clark's desiccated compost,	60	..	65
Daniell's manure,	50		
Dutch ashes,	40		
Guano, foreign,	56		
Putter's,	65		
Gypsum,	80	..	84
Hunnis, Lance's,	56		
Turnbull's,	58		
Lance's carbon,	45		
Lance's manures,	70		
Muriate of ammonia,	65	..	70
Nitrate of potash,	75		
soda,	80		
Poittevin's desiccated compost,	18		
Rape-dust,	56		
Soda ash,	60		
Sulphate of ammonia,	70		
soda,	60	..	65
Urate,	50		
Watson's compost,	40	..	45

4978. The above is a formidable array of auxiliaries to farmyard dung for the contemplation of the farmer. Without a classification, he would feel bewildered amongst them; and even when classified, the names of many of the manufactured ones afford him no information as to their component ingredients. The natural ones are most to be relied on, as they afford both stimulating and fertilising materials. The saline are generally impure, as may be seen in comparing their prices with those of the genuine salts in the shops of the druggists. The refuse manures are numerous, and, being generally cheap, may be employed to advantage in composts, or separately. The manufactured ones are also a numerous tribe, and from their very number are apt to excite suspicion. I have myself tried at least one of those to be found in the above list, and found it do as little good as so much black mould applied beside them. Even the famed Liebig's manure has proved a failure; and recent decisions in the courts of justice have proved that useless and inexpensive mixtures have been sold to farmers bearing the name of good manures containing valuable ingredients. We have only to look at the composition given in (3351,) to learn the nature of many stuffs which are passed off as natural guano. The great objection to concocted manures is, that you can have no reliance on the effects to be produced by parcels of them obtained at different times, or even from different parcels obtained at the same time. Those made up in large quantities at once, and in a limited time, cannot have their ingredients commixed with the desired degree of precision. Hence one small parcel produces one effect, and another quite a different effect. Were chemists more intent on supplying farmers with well-considered prescriptions, setting forth the proportions which genuine ingredients should bear to one another, —and indicating the crop each mixture is intended to promote, accompanied with such instructions as the farmers themselves might make up the mixtures in safety—than in concocting compounds for sale, they would confer far more valuable service on practical husbandry than they have hitherto done. They might not thus make so much money in a given time, but

they would receive a much steadier custom. I do not suppose but that chemists could make up the mixtures better than the farmer; and were a skilful chemist to make up prescriptions for the land as honestly as he does for patients, or for the domesticated animals, I am sure he would establish for himself a large and lucrative trade; because farmers would much rather receive a manure already made up, in which they can confide, than run the risk of mixing one, in the doing of which they might commit a serious mistake. But as manufactured manures are presented to the farmer at present, he has no alternative but to have every sample analysed by a chemist, in no respect connected with a manufactory; and even then he has no positive assurance of receiving the stock in as pure a state as the sample. Every other trade that deals in pulverised articles is in the same unsatisfactory state. No one is even certain of purchasing genuine oatmeal in the shops; and as to tea, it is adulterated beyond endurance with the leaves of other plants; and they who purchase ground coffee receive a large proportion in it of chicory. When I mention that many of the saline ingredients, enumerated above, are rendered heavier by the addition of water, even to the extent of 14 per cent, I speak no more than the truth, and adduce sufficient grounds to warn the farmers from purchasing manufactured compounded pulverised mixtures, whose composition cannot be estimated by sight.

4979. In applying all special manures, certain rules should be followed. It is the safest practice to avoid bringing the seed sown in immediate contact with any special manure, so that a portion of soil should always intervene between the manures and the seed.

4980. Earthy special manures should always be sown upon the ground after it has been drilled up, whether they are used as a substitute or as an auxiliary to farmyard dung; and the saline manures may be treated in the same manner, when desired to be so used.

4981. But saline special manures, being easily dissolved, are most efficiently applied to the crop after the plants have developed their leaves, and in the form of a top-dressing. In very dry weather, the saline ingredients will rather injure than promote vegetation, so that a time of rain, or of heavy dew early in the morning, should be chosen for their distribution over the soil.

4982. Substances in a highly soluble form, such as the sulphates, muriates, and nitrates, owing to their solubility, ought to be sparingly applied each time, but repeatedly, say in two, three, four, or five applications, in order to produce their greatest practicable results at the smallest expenditure of materials. This point still wants elucidation, and can only be made practical by repeated experiments undertaken by farmers with this sole object in view. Three to five years of such a course of experiment would put us in possession of indisputable data for future guidance.

4983. Every one has heard extolled the great industry displayed by the Chinese and Belgians, in collecting special manure for every species of crop. Mr Fortune gives a very good reason for such industry on the part of the Chinese: "Firewood," he says, "is so scarce in the country that a great portion of the straw, cotton stalks, and grass, which would go to manure the fields, is used for firing, and therefore the plan of growing manure for the land is forced upon the farmers by necessity. The plan of using manure in a fresh state, instead of allowing it first to decay, has doubtless been found, from long experience, to be the best for the young paddy (rice.) . . . Prawns and fish of various kinds are frequently used for the same purpose, and in the same way."

4984. *Black earth.*—"Burnt earth mixed with decomposed vegetable matter is another highly esteemed manure, and is common in all the agricultural districts. During the summer months, all sorts of vegetable rubbish are collected in heaps by the road sides, and mixed with straw, grass, parings of turf, &c., which are set on fire, and burn slowly for several days, until all the rank vegetable matter is decomposed, and the whole reduced to a black earth. It is then turned over several times, when it presents the same appearance as the vegetable mould used in gardens in England. This manure is not scattered over the land, but reserved for covering the seeds, and is applied in the following manner:—When the seed-time arrives, one man makes the holes, another follows and drops in the seed, and a third puts a handful of the black earth on the top of them. Being principally vegetable matter, it keeps the seeds loose and moist during the period of germination, and afterwards affords them nourishment. This manure is used mechanically as well as chemically in a stiff soil, like that of the low lands of China, where the seeds are apt to be injured in the process of germination. The young crop thus planted acquires a vigour in its growth, which enables it to assimilate the matter which forms the strong soil, and to strike its roots firmly into it." This practice is analogous to the one of putting powdered charcoal near the turnip seed, to retain and collect the moisture about it in dry and strong land in dry weather. The Earl of Essex tried charcoal in this way with success.*

4985. *Oil-cake.*—"What is commonly known by the name of oil-cake is broken up and used in the same manner as the vegetable earth, and is also scattered broadcast over the land. The oil-cake is the remains or refuse of the seeds of different plants, such as the tallow tree, various kinds of beans, and of the cabbage. There is a great demand for this manure in all parts of the country, and it forms a very considerable branch of trade both by sea and land. Bones, shells, old lime, soot, ashes, and all kinds of rubbish, are also eagerly bought up by the farmer for the purpose of manure."

4986. "In the Fatee gardens near Canton, the

proprietors have a curious kind of rich weed, which they cut into small square bits, and sell at a very high price for the growing of plants in pots. This is obtained chiefly from the ponds and lakes in the vicinity, where the *Nelumbium speciosum* grows. This soil is so much esteemed, that the price for the best kind is 1 dollar for 3 peculs, (3 cwt. 63½ lb.) and for the second best 1 dollar for 4 peculs (4 cwt. 85 lb.) The inferior sort has frequently been sent to England in plant cases from Canton."

4987. *Nightsoil and urine.*—"For crops in a vigorous growing state no kind of manure is so eagerly sought after as nightsoil, and every traveller in China has remarked the large cisterns or earthen tubs, which are placed in the most conspicuous and convenient situations for the reception of this kind of manure. What would be considered an intolerable nuisance in every civilised town in Europe, is here looked upon by all classes, rich and poor, with the utmost complacency; and I am convinced that nothing would astonish a Chinaman more than hearing any one complain of the stench which is continually rising from these manure tanks. Almost every Chinese town is placed on the banks of a river or canal, and the water is not only generally led around the walls, thus forming a kind of moat, but also through many parts of the city. Long clumsy boats are placed in different parts of the town, into which the nightsoil and urine are emptied, and conveyed from thence into the country. The fields in the neighbourhood of cities are generally supplied with it by Coolies, who go every morning to market loaded with the produce of their farms. Each brings home two buckets of the manure, slung at the ends of his bamboo pole. In England it is generally supposed that the Chinese carry the nightsoil and urine to their tanks, and leave it there to undergo fermentation, before they apply it to the land. This, however, is not the case—at least not generally. In the fertile agricultural districts in the north, I have observed that the greater part of this stimulant is used in a fresh state, being of course sufficiently diluted with water before it is applied to the crops. And there can be little doubt that in this the Chinese act perfectly right, as the manure must be much more efficient in this state than when a great portion of its ammonia has passed off into the air. The Chinese, as far as I could learn, have no mode of disinfecting their manure; but they seem to be perfectly aware that, if allowed free access to the air, a great loss must result, owing to the gases which are given out and dissipated. Without waiting, then, for fermentation or putrefaction, the manure is at once applied to the growing crops. On the afternoons, or in cloudy days, the labourers are seen carrying water from the nearest pond or canal to the manure tank, for the purpose of diluting its contents. This being done, they fill their buckets, attaching one to each end of their bamboo in the usual way, and carry them off to their destination. When this is reached, each man takes a small wooden ladle having a long bamboo handle, and with

this he scatters the liquid over the growing crop. A strong stimulant like this would probably, in other circumstances, have an injurious effect; but, by using it only when the crops are young and luxuriant, they assimilate its gases, and a most marked effect is produced upon their growth and productiveness. This kind of liquid manure is generally applied to wheat, barley, and all the cabbage tribe, and other garden vegetables; but not to rice, which is always flooded during its growth. This manure is sometimes used after putrefaction and fermentation has taken place, and even in this state it is very efficient. In the gardens near Canton, it is often dried and mixed with the soil taken from the bottom of the Lotus ponds, and used for growing plants in pots, or for enriching any particular tree which may be a favourite in the garden.*

4988. *Dr Radcliff* mentions that, in Belgium, the urine from the cattle byres and horses' stables, collected in the manure tanks (2062), is enriched by the addition of rape-cake in the proportion of from 2000 to 4000 rape-cakes of 2 lb. each to 38,000 gallons of urine, and also with the nightsoil from privies—the mixture being applied in given quantities to the particular crop, varying from 10½ to 21 tons to the acre.†

4989. *Dutch ashes*.—Dutch ashes produce extraordinary benefit to the clover crops in Holland and Flanders. They are derived from burning dried baked peat in Holland, in the following manner:—"In Holland there are two kinds of turf or peats used for burning—namely, those cut as in this country from the bogs, which burn easily, but give a whitish kind of ashes, which are of little use; and another kind, more generally used, as being more durable. Having witnessed the mode of making this kind," says Mr John Mitchell, Belgian Consul, Leith, "I shall here describe it. At those ditches or ponds made by cutting away the common peats, or upper part of the bogs, men are employed in dragging from the bottom, by means of long sticks, having hooped bags at the end, the soft portion of the peat under water, which they pour out on the adjacent ground, where the water is allowed to drain off. After exposure to the air, this substance becomes in a few days sufficiently consistent to be cut into pieces of the size of a common building brick, which are dried for use. The ashes from this kind of peat are of a yellowish-brown colour, and are of the kind so much prized in Flanders that carts go regularly round to the various houses where this turf is used, and carefully collect all the ashes that can be obtained."‡ A proverb is known in Flanders in these terms:—"He who buys ashes for clover pays nothing; but he who neglects doing so, pays a double price." The composition is as follows, according to Sprengel:—

	DUTCH ASHES (grey.)		
	Best quality.	Inferior quality.	Worst quality.
Potash, . . .	0.2	0.2	0.1
Soda, . . .	1.0	3.9	0.4
Lime, . . .	13.6	8.6	6.1
Magnesia, . . .	4.9	1.6	3.9
Oxide of iron, . . .	6.6	5.4	4.1
Oxide of manganese, . . .	1.0	4.3	0.2
Sulphuric acid, . . .	7.2	6.4	3.4
Phosphoric acid, . . .	2.0	0.8	1.3
Carbonic acid, . . .	4.1	6.4	5.5
Chlorine, . . .	1.2	3.0	0.5
Alumina, . . .	4.5	3.5	4.1
Silica, . . .	47.1	55.9	70.4
Charred turf, . . .	6.6	...	...
	100.0	100.0	100.0§

4990. *Charring peat*.—Mr A. Grant, Galson, Stornoway, Isle of Skye, gives what seems a good way of charring peat, without incurring the trouble and expense of drying the moss into peats before charring. "When beginning to cut the sod," he observes, "I take a man that I know to be an active steady spademan, and set him to cut a sod right across a given space. When he has advanced five or six sods I set another to follow him, and so on until there are as many as the space will give room to work on. When the whole are started, it will be seen that there is an equal distance between each man, and that if one works less than another, he is immediately cut out by the man following him. This he will hardly submit to, and the consequence is that they all work regularly, and at the same rate as your best man, who is their leader. The sods should be about a foot square, and if the weather should be dry, they will burn in about ten days or less; but if it has been showery, you must take up the sods and place them in small heaps, along the space dug to dry. When dry, the fires should be lighted at the distance of about ten yards, in a straight line along the space. The size of the fires will depend on the depth at which the sods were cut, and the quantity as well as the quality of the charcoal will depend on the state of the sods when burning. If they have been wet when the fires were lighted, although they will burn, still the fire cannot penetrate so fast into the centre of the sod, and the consequence will be that a great proportion will be reduced to ashes before you can cover your fires. As soon as the fire begins to break out through the heap, and you see that the whole mass is properly lighted, you must begin covering the fire very carefully with wet peat, beginning at the foot, and rising gradually with it, until you have the whole covered—just in the way a potato-pit is covered—and if the work has been well done, very little smoke will escape; but if there should, you must put more cover on that particular spot,

* Fortune's *Wanderings in China*, p. 308-13.

† Radcliff's *Agriculture of Flanders*, p. 49 and 90.

‡ *Prize Essays of the Highland and Agricultural Society*, vol. iv. p. 108.

§ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 629.

and beat the whole down smoothly with the back of a spade. In this way you will have a large proportion of fine charcoal, and very little will be burnt to ashes."* In other places, such as Lancashire, kilns of sods are constructed for the charring of peat, and the fire is commenced in them at the bottom by means of dried peat.†

4991. *Burning clay.*—Burning clay was in great vogue in Scotland about 30 or 40 years since, when all the clay districts in summer seemed to be covered with smoking heaps. Like every impulse of the kind, the fires soon subsided, but in England the practice is continued in many parts. There are two modes of burning clay sods—in large kilns of sods, and in heaps—the latter being the simplest and most economical method, and is the one practised in Suffolk and Essex. The chief thing to be provided with is a good body of fire before any of the clay sods are put on, and the sods are laid on in the form of conical heaps so as to regulate and restrain the fire; and when all this has been done, little attendance is required at the heaps. The expense of preparing such clay ashes per 100 loads, has been thus estimated by a veteran clay-burner, Mr Poppy, of Winesham, in Suffolk :—

Digging and burning sods at 9d. per load, . . .	L.3 15 0
Filling, 1s. 6d. the 20 loads,	0 7 6
Carting, 3 horses and 2 men,	0 16 0
Filling and spreading after burning,	0 15 0
Carting and laying on over 2 acres,	0 16 0
	L.6 9 6

Being £3, 4s. 9d. an acre, allowing 50 carts to the acre.

4992. *To prepare Granite manure.*—Mr J. Prideaux of Cornwall recommends the burning of granite where that rock abounds, in order to obtain its potass for manure. This, being a new manure, would require to be tried at first on a small scale. From its slow solubility its effect is likely to be rather in the weight of produce, for four or five successive crops, than striking the eye at first. The silica it contains, combined with the potass, is likely to stiffen the straw of wheat and other grain; and it would seem to be especially suitable for the peat soils, upon the granite, they being deficient in its ingredients, potash, silica, lime, and alumina. The granite itself is in too hard and compact a state to yield to the weather fast enough for the purposes of a manure. But this hardness is not difficult to reduce. By turning, whilst red hot, into water, it is rendered quite brittle and crumbling; and, being then mixed with fresh lime and water, is made much more susceptible of decomposition, and easily yields part at least of its potash. The surface granite, already softened by the weather, will not do, having already lost a part of its alkali; the chippings and fragments of the solid stone, accumulating at the granite quarries, may be heated with turf in common limekilns, and raked down into water as fast as they get red

hot—in which manner many tons per day may be done in one kiln. Thus rendered brittle, it may be rapidly crumbled by a water-power crushing-mill. And as turf and water are both plentiful about the granite, this rough powder might be sold to the farmer at a lower price than lime. Turf is the best fuel for the purpose, because it gives a low heat, and the lower red heat it has the tenderer it becomes. But where farmers have to burn it in the limekiln, at a distance from the turf country, the coom used for lime will do very well, requiring less than half the proportion used for limestone; and it need not be in the kiln above one quarter the time required for lime. But it must go directly into the water whilst red hot, else it will harden again in cooling. As soon as it is hand cold, it may be drawn out of the water, to make room for more. The finer it is crushed before mixing with the lime, the better. It might even be burnt upon the ground in heap, with cinders and coal-ashes, and a little coal to light it, (like clay burning;) and when red hot through, the water is thrown on, to quench it; but there would be some parts not red hot when the water reached them, and these would not be much softened, so it is better to use a kiln if within reach.

4993. A ton of this powdered granite, mixed with a ton of fresh lime, being heaped up on a thick bed of earth, and closed in all round with earth, leaving the top open, water is to be poured on gradually, enough to slake the lime entirely, and then all covered in, the bed of earth at bottom being about 2 feet thick, and round the sides 8 or 9 inches, making good the cracks produced by the swelling of the lime in slaking. After two or three days it may be uncovered; the granite and slaked lime well mixed up with more water to a soft mortar; and again all covered in close with earth. In this state it may be left two or three months at least, and better if longer—keeping it always wet and soft. When wanted to use, the whole heap should be well mixed together, including the earth, which will be impregnated with solution of potash. It is then fit for spreading, or mixing with other manures.‡

4994. *Rape-cake and Rape-dust.*—Rape-cakes should be of a yellowish green colour when new, but they become dark on being long kept. They should be put past in the apartment allotted for their accommodation in a dry day and on a dry clay or wooden floor—and, except by their weight, they do no injury to wood; but they should be neatly built up, free of the walls, in case they should draw damp from them. The air, and especially damp air, should be excluded from the apartment, as it is the cause of mouldiness, and of losing their light colour. New-made cakes will heat a little after they are built up, but after the sweat they have had in the ship this will not be great; and to prevent heating as much as possible, the small dust of the cargo should be kept by itself.

* *Ross-shire Advertiser*, 14th July 1845.

† *Gardeners' Chronicle*, 1844.

‡ *Gardeners' Chronicle*, 9th December 1848.

4995. It is not likely that you will have occasion to keep rape-dust—that is, rape-cake after it has been crushed to powder; but in case you should wish to keep it in that state, the mode of doing so is as follows:—It should not be put together in a thick heap, for, however dry it may seem, and however dry it may be kept, sooner or later it will heat. When put by dry on a dry floor, it may be three weeks or a month before it will heat; but if damp it will heat soon, and the heat will become insufferable to the hand. Whenever it begins to heat it should be carefully and slowly turned over in shallow bins to cool it. When heated to excess it becomes burnt as black as soot, and gets into lumps like coal-cinders, from which it is not easily distinguished, and in which state its efficacy is impaired. Many throw rape-dust into a corner of a cart or turnip-shed where pigs and fowls find their way to it, and where it is constantly exposed to the moisture of the air; a practice to be avoided. You should purchase none but newly crushed rape-dust.

4996. *Gypsum*.—In the first part of his inquiry into the way in which gypsum acts when employed as a manure, M. Caillat has endeavoured to show that the method of calcination usually resorted to, for the purpose of obtaining the inorganic parts of plants, gives inaccurate results. The weight of the ash does not represent the mineral parts: in consequence of the high temperature to which a plant is exposed when calcined, there is a loss in the quantity of nearly all its inorganic components; and the sulphates especially are, to a great extent, either decomposed or destroyed. M. Caillat, by treating plants, such as lucerne, clover, and sainfoin, with diluted pure nitric acid, succeeded in eliminating nearly the whole of the mineral matters present; so much so, indeed, that, when the pulp was afterwards washed and burnt, not more than one-fifth per cent of ash was left. This small residue consisted of silica and a small quantity of peroxide of iron, both of which are insoluble in the acid employed. This method of proceeding always gave more mineral matter than could be obtained by calcining an equal quantity of the same plants; and it has been thus ascertained that there exists in many vegetables, especially in the leguminous plants used as fodder, much more sulphuric acid than has been hitherto supposed.

4997. M. Caillat has ascertained that the loss of sulphuric acid in the process of calcination arises from a partial decomposition of the sulphate of lime. When, for example, he mixed a known weight of pure burnt sulphate of lime with wheat starch in the form of paste, and calcined the whole, the residuary ash did not yield as much sulphuric acid as the sulphate of lime used contained. He also found, by another direct experiment, that sulphate of lime, converted into sulphuret of calcium by the action of organic matter at a high temperature, became, in part, converted into carbonate of lime, under the influence of the oxygen in the air: this

oxygen, burning at the same time both the sulphur of the sulphuret and a part of the interposed carbon, forms sulphurous acid, which is given off, and carbonic acid, of which a certain portion remains combined with the lime, and thus helps to displace the sulphur. "In a future memoir, M. Caillat proposes to examine and compare the mineral substances contained in leguminous plants growing on soils of like nature, but some of which have, and others have not been manured with gypsum; and he expects to show that it is probable that gypsum naturally finds its way into the crops which it occasions to grow so quickly. By the above method of treating plants with nitric acid, the silica, which lies in the tissue of the epidermis, was isolated as completely as possible: it was perfectly white. By examining silicious pellicles taken from some grasses, which, as is well known, contain a great quantity of silica in their epidermis, "I found," says M. Caillat, "that this silica, moulded in the cells of the skin, is very curiously disposed. It exists in little plates, from one to two hundredths of a millimetre broad, according to the plant, packed side by side, but whose edges are not smooth; but indented very regularly, and thus articulated laterally. This organisation of the silica, which has not, so far as I am aware, been yet remarked, seems to me to be worthy of the attention of physiologists."*

4998. *Shell-fish and Shells*.—Ground mussel and oyster shells are used as manure for turnips; but double the quantity does not produce the same effect upon the crop as bone-dust; perhaps it would require 40 bushels to produce the same effect as 16 bushels of bone-dust. One use made of shell-dust is the adulteration of bone-dust. Wheelks, cockles, and mussels, 16 bushels per acre, the bushel weighing 1 cwt., have been employed with success to raise turnips. Such manure is obtainable by those residing near a rocky shore, where no fishermen have their haven—for there they gather and use such shell-fish as bait.

4999. *Shell-marl*.—In some parts of the country, as in Forfarshire, this substance is found in considerable quantities associated with peat. It occurs in beds in deep peat-bogs, lined above and below with a layer of very fine unctuous clay. It is taken out of the bogs by means of a boat mounted with a dredging apparatus. When of fine quality, and in a dry state, it is as white as lime, not crumbling down into powder like quicklime, but cutting something like cheese with the spade, and adhering in large lumps when spread. It is applied at the rate of from 40 to 50 bolls an acre, the boll containing 8 cubic feet, and costs 9d. the boll, making the manuring £1, 10s. to £1, 17s. 6d. an acre, exclusive of carriage. When applied to land as lime, it is beneficial; but, as is too often the case, when applied solely as a manure, in quantities of 35 to 45 cubic yards an acre, it never fails to be mischievous. It does not easily injure new fresh land; but when repeated frequently as a sole manuring, I have seen old land reduced to such

* *Comptes Rendus*, August 1849.

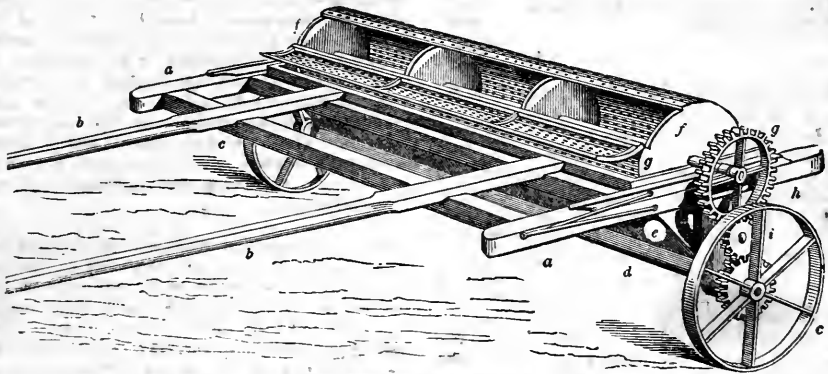
a state of pulverisation, that the foot, with a stamp, sank into the ground as deep as the ankle, and raised a dust with the stroke. "Applied to lands followed by severe cropping," remarks Mr Headrick, "it has reduced them almost to a state of utter sterility, which they have not recovered to this day."*

5000. *Soot*.—Soot is a good top-dressing for grass, though it renders pasture rather distasteful to cattle. Being a very dirty article to distribute by the hand, any machine that distributes it broad-cast will prove useful on farms where it can be easily obtained in quantity. The follow-

ing is a description of a machine that has proved itself useful.

5001. The *soot-sowing machine*, from the limited supply of the article upon which it operates, can never be ranked amongst the most important class of machines on the farm; still, owing to the powerful effect of the manure itself, its due distribution is of importance, and, from its extreme lightness, it cannot, without disadvantage, be sown by the hand. The machine here described was the production of Mr Main, factor to the Marquis of Dalhousie.† Fig. 436 is a view in perspective, the horse-shafts being broken off.

Fig. 436.



THE SOOT-SOWING MACHINE.

The machine consists of a bed-frame *a a*, to which the horse-shafts *b b* are attached, and is mounted on a pair of low wheels *c c*, fixed upon and turning with the axle, around which there is built a wooden cylinder *d*, fluted longitudinally. A chest *e* is appended to the body-frame, and descends so far as to half embrace the cylinder *d*, and is surmounted by a semi-cylindrical cover, which is left out of the figure. In the interior of the chest is placed a cylinder of sheet-iron *f*, perforated all over with holes of half-inch diameter, and as much apart, giving to it the character of a riddle. The cylinder is closed at both ends, and has a trap-door on one side, hinged, and secured at each end with hook and eye. An axle of iron passes quite through the cylinder, having journals that rest in two jointed bars *g g*; and on one end of the axle, produced beyond the bar *g*, is mounted a wheel *h*. The axle of the carriage-wheels *c* carries also a wheel, and the two are connected by means of the intermediate wheel *i*, thus producing motion in the perforated cylinder, as well as in the fluted one that is carried by the axle. The purpose of the perforated cylinder, into which the soot is first delivered, is to separate stones or other hard substances that may be mixed with it; that of the fluted cylinder is the distribution of it from the machine; and that of the hinged cover to prevent it flying off during the agitation by the first cylinder.

5002. The operations of the soot-machine are effected thus:—A charge of soot is put into the cylinder, the chest closed, and the machine put in motion. By the revolution of the upper cylinder, the soot is separated from the stones and refuse with which it is always mixed, and so passes into the lower part of the chest, from whence, by the revolution of the fluted cylinder, regulated by a brush extending the whole length of the cylinder, it is distributed in an equal manner upon the ground. When the soot has been discharged from the upper cylinder, the cylinder is raised from the chest by means of the knee-jointed bars *g g*, and when so elevated, the trap-door is opened, and the stones and other refuse discharged, preparatory to the next charge of soot.

5003. The machine constructed as above described, has been found liable to the inconvenience of ceasing to perform its wonted duties, by the soot being converted into a paste by the action of the revolving parts of the machine, whenever the soot happened to be damp; but which has been effectually rectified by the adoption of broad-cast distributing-wheels, in place of the fluted roller. The bottom of the chest is consequently closed, except the orifice for each wheel, all the other parts of the machine remaining as they were; or by a proper adjustment, the intermediate wheel *i* is left out of the construction. It is also to be observed, that the distributing

* Headrick's *Agricultural Survey of Forfarshire*, p. 406.

† *Prize Essays of the Highland and Agricultural Society*, vol. xii. p. 535.

orifices for soot require to be about $1\frac{1}{4}$ inch diameter.

5004. No correct analysis of coal-soot has yet been made; but as long since as 1826, Bracconot made the following one of wood-soot:—

Ulimin—a hydro-carbon, not well defined	30.20
Azotised matter	20.00
Carbonate of lime, and a trace of carbonate of magnesia,	14.66
Water	12.50
Acetate of lime,	5.65
.. potash,	4.10
.. magnesia,	0.53
.. ammonia,	0.20
Sulphate of lime,	5.00
Carbonaceous matter, not soluble in alkalis,	3.85
Ferruginous phosphate of lime,	1.50
Silica,	0.95
Asbolin—a peculiar acid and bitter principle,	0.50
Chloride of potassium,	0.36
	<hr/>
	100.00

5005. *Coprolites*.—In the lower region of the lias at the Aust Passage Cliffs, on the left bank of the Severn, near Bristol, is the well-known bone-bed, where two beds of lias, each from one to two feet thick, are densely loaded with dislocated bones, and teeth, and scales of extinct reptiles and fishes, interspersed abundantly with coprolites derived from animals of many kinds. Coprolites are also dispersed plentifully through the strata of many other parts of the lias, as on the coast at Lyme Regis; but neither there, nor in the bone-bed at Aust Passage, is a sufficient quantity accessible at a cost that would repay the digging for the express purpose of collecting these mineralised fragments of skeletons and faecal balls of digested bones for use as a substitute for recent bone-dust or guano. Geologists have long been acquainted with the abundant occurrence of rolled fragments of the bones and teeth of large quadrupeds, and of many marine fishes in the tertiary beds of gravel and shells, called crag, in the counties of Norfolk and Suffolk; and in 1846 an abundance of the ear shells of whales, in the crag beds of Felixton, on the coast of Suffolk, together with large quantities of rolled pebbles of phosphate of lime, then supposed to be coprolites, were found among the miscellaneous gravel and shells that compose the bulk of the crag formation.

5006. The following is an analysis of coprolites by Mr T. J. Herepath of Bristol:—

Water,	3.400
Organic matter,	trace
Silica,	13.240
Carbonate of lime,	28.400
Phosphate of lime,	} 53.730 — phosphoric acid, 26.615
Magnesia, iron, &c.	
Sulphate of lime,	0.736
Loss,	0.494
	<hr/>
	100.000

The idea formed by Dr Buckland with regard to the nature of coprolites is probably correct, and the supposition is borne out by the following analysis of the bone of an ox, which the coprolite closely resembles in composition, when the bone is deprived of its fat and moisture:—

Phosphate of lime,	56.752
Phosphate of magnesia,	3.256
	<hr/>
	50.008 — phosphoric acid, 27.688*

5007. Mr Lawes has established on the east bank of Deptford Creek, near Greenwich, very extensive works for grinding to powder these false coprolites or phosphates, to supply farmers with a valuable substitute for guano, under the accepted name of “coprolite manure.”†

5008. *Dried carcasses of animals*.—It is known that large quantities of the hides of cattle and horses are imported into this country annually from South America. The carcasses from which those skins had been taken are left to be devoured by birds of prey and wild beasts, but their bones are collected and exported to this country. I have recently learned that the flesh of these carcasses is now not to be lost but is dried, most probably in the sun, and sent to this country for manure. Thus we may expect that a large amount of animal matter may soon be made available for the nitrogenous enrichment of our compost heaps.

5009. A large skin trade also exists from the cattle of the Ukraine, and there the carcasses of the cattle are boiled down for the sake of the fat, which when collected is sent to this country as tallow, and the flesh thrown away. The tallow collectors, however, may be induced to dry the boiled flesh of the oxen and separate it from the bones, and send both to this country for manure, as well as they do the tallow in commerce.

5010. Owing to the very low price of mutton in Australia for several years past, the colonists have been induced to boil down the carcasses of their old sheep, after depriving them of their skin, in order to collect the fat and export it to this country. They might dry the boiled flesh, separate the bones, and convert both into an article of commerce for this country. Thus large quantities of the richest animal manures may yet reach this country from abroad, of much greater value than many of the compounds offered at home as manures to the notice of the farmer.

5011. *Sugar refuse*.—The following analysis of sugar refuse was made by Professor Johnston, for the Leith Sugar-Refining Company, and the Messrs Schultz have kindly furnished me with it.

Water,	60.26
Organic matter, (refuse blood and sugar, containing 1.06 of ammonia,)	} 20.77
Common salt, sulphates and phosphates of potash and soda,	
Phosphates of lime and magnesia,	8.67
Carbonate of lime,	3.55
Insoluble silicious matter and alumina,	5.98
	<hr/>
	100.00

It will be observed that the percentage of water

* *Journal of Agriculture*, July 1849, p. 74.

† *Journal of the Agricultural Society of England*, vol. x. p. 520-3.

is large, on which account the carriage of this refuse to a distance is expensive; and the process of depriving it of a part of its water would be too expensive. The quality of this article varies according to the mode of manufacture pursued.

5012. *Animal charcoal*.—Sugar refiners use a large quantity of animal charcoal; and as it becomes necessary occasionally to separate the finer particles by riddling, they dispose of the latter for manure, which is found valuable as a top-dressing for grass, and might, no doubt, be used with turnip seed to absorb moisture around it in dry weather in strong land.

5013. *Sewerage water of towns*.—The water flowing from the common sewers of towns may be regarded as a special manure. It must contain many very valuable ingredients, such as the contents of water-closets, the drainings from kitchens, and the washings from many sorts of manufactures. The Metropolitan Sewerage Manure Company was established in 1846 for the purpose of delivering the water from the sewers of London to parties in the country who might choose to employ it as a manure; and the efficacy of such manure is believed to be great everywhere from witnessing the effects produced on the Craigenfinny meadows in the neighbourhood of Edinburgh. There, the irrigated meadows are begun to be cut for green food for cows in April, and continued at intervals until the end of November. As a natural consequence, the worth of the soil has risen in rent from 30s. and £6 an acre, to £20 a-year. It is imagined that the sewerage water ought to have the same effect on arable as it has on grass land, but such a result by no means follows; and a stronger instance of disbelief in its good effects on land under the spade, cannot be given than the simple statement of the fact, of the vegetable gardeners of Edinburgh not using it as manure in raising vegetables, though many have the opportunity of doing so if they choose. Whenever a run from a public sewer passes through their gardens, they convert as much of the ground into a meadow as the water will fully irrigate, to supply their cows with green food; and every gardener keeps cows where he has a byre to accommodate them; but, to raise vegetables, they purchase cows' urine and cow and horse dung from the cow-feeders and livery stable keepers, at a large price. For example, they pay 5s. the ton for the dung, and from 4d. to 6d. the butt of 102 gallons for the urine; and they apply 60 tons of the dung, and as many gallons of the urine in proportion to the acre, during the season, at a cost of £15 an acre.

5014. To cart sewer water to a distance is attended with more trouble and expense than it is worth. To avoid the inconvenience, the Sewerage Manure Company propose to pump the water from the sewers by means of steam-engines, and distribute it for miles into the country through iron pipes, at 25s. the 100 tons of the water. Now a very small proportion of the bulk of the sewerage water is solid matter—

one gallon of the King's Scholars' Pond sewerage at London affording only 85.34 grains of solid matter. This quantity of solid matter is partly soluble and partly insoluble. The soluble portion weighs 74.80 grains, and contains of—

Ammonia,	3.29	grains.
Sulphuric acid,	0.62	...
Phosphate of lime,	0.29	...
Lime,	6.05	...
Chlorine,	10.00	...
	<hr/>	
	20.25	...
Potash, soda, soluble animal and vegetable matter,	53.55	...
	<hr/>	
	74.80	...

The insoluble portion weighs 10.54 grains, and contains of—

Phosphate of lime,	2.32	grains.
Carbonate of lime,	1.94	...
Silica,	6.28	...
	<hr/>	
	10.54	...

In large quantities, these proportions only afford 1 ton of soluble and insoluble matter in 560 tons of water.

5015. The sewerage water of London is not so rich as that of Edinburgh. Thus, one gallon of the clear liquid of the Edinburgh sewers, evaporated to dryness, gave 117.05 of solid matter, of which 78 grains were soluble, and contained of—

Ammonia,	4.45	grains.
Sulphuric acid,	3.00	...
Lime,	6.84	...
Magnesia,	trace	...
Chlorine,	12.10	...
Phosphate of lime,	1.06	...
	<hr/>	
	27.45	...
Potash, soda, soluble animal and vegetable matter, }	50.55	...
	<hr/>	
	78.00	...

The insoluble part weighed 39.05 grains, the animal matter predominating, and contained of—

Phosphate of lime, coloured with iron, }	6.6	grains.
Carbonate of lime,	2.7	...
Magnesia,	0.25	...
Earth and sand,	29.5	...
	<hr/>	
	39.05	...

5016. The cartage of 560 tons of water, in proportion to 1 ton of fertilising ingredients held in it, is so expensive that it is proposed to distribute the water over the land by means of cast-iron pipes, laid permanently under ground. When a farm is proposed to be manured with the sewerage water of towns, instead of solid dung, a system of pipes is required to be laid down in every field in connection with a main pipe, which originates at a tank at the steading, and through which the liquid manure must be propelled by means of the steam power which is used for the purposes of the farm at the stead-

ing. The late Mr Smith of Deanston gave an estimate of the cost required to distribute liquid manure over a farm of 400 acres, both with earthen and cast-iron pipes. The statement in regard to earthen pipes was this:—

Steam-engine of 10 horse power, including boiler, gearing, &c.,	L.250	0	0
5600 yards main stoneware pipes, 3 inches in diameter at 1s. 4d. the yard laid down,	373	6	8
Manure tank, 50 feet long by 12 feet broad, and 8 feet deep built and arched in masonry, 7 roofs at L.6, 10s. the roof,	L.45	10	0
Digging 430 cubic yards, at 1s. the yard,	21	10	0
Concrete for puddle, 50 cubic yds. at 5s.,	12	10	0
		79	10
200 yards of gutta percha, bore 2 inches diameter, at 3s. per yard,	30	0	0
Cranes, &c.,	8	3	4
5 per cent. for contingencies,	39	0	0
Amount of outlay,	L.780	0	0

That is, L.1, 19s. in the gross, or 1s. 11 $\frac{1}{2}$ d. yearly interest per acre. The cost of cast-iron pipes was as follows:—

Steam-engine as above,	L. 250	0	0
5600 yards of cast-iron pipes, 3 inches diameter, at 2s. 6d. the yard laid down,	700	0	0
Manure tank, as above,	79	10	0
Hose, as above,	30	0	0
Cranes, &c.,	8	3	4
5 per cent for contingencies,	52	6	8
Amount of outlay,	L.1120	0	0

That is, L.2, 16s. in the gross, or 2s. 9 $\frac{1}{2}$ d. yearly interest per acre.*

5017. That liquid manure proves beneficial to the grass land of the farm, and that sewerage water has raised the value of meadow land in the neighbourhood of Edinburgh very considerably, is beyond doubt; but that the sewerage water of towns is a proper application for arable land anywhere has by no means yet been proved. Let us consider the probable effects of using sewerage water upon the land which only contains 1 ton of fertilising matter in 560 tons of water. It is desirable the turnip land should receive 20 tons of farmyard dung to the acre; but let us take 16 tons as nearer the quantity on the average. It is alleged that every kind of manure in a liquid form is much more effective than in a solid one. This is only assertion—we have no proof of it. No doubt, we believe that plants only receive manure into their textures in a state of solution; and in as far as the soluble ingredients of the manure employed are concerned, they may be taken up by the plants in a shorter time than when applied in a solid form. But there is no reason for believing that, when the solid manure is dissolved in the soil by rain water, it is less acceptable to plants than if it had been applied directly in a state of solution; because, if we put greater faith in the dissolved manure supplied by ourselves, we must prefer our own agency to that of nature, and believe

that the plant prefers the manure in a liquid state from the hand of man, to that prepared by the rain-water. The effect of solid and fluid manure is thus in fact a mere question of time, and not one of quality or efficacy. Can we believe that it is better for the land that a large quantity of water should be put upon it at once than as it gradually falls from the heavens? I think we cannot, as long as we do not know the exact periods of a plant's growth when manure is most acceptable to it. But granting that fluid manure is more efficacious than solid, and that 10 tons in that state tell as sensibly upon vegetables as 16 tons in the solid state, let us follow the effects of its application. To receive 10 tons, the acre must be deluged with 5600 tons of water, which would stand to a height of 54 $\frac{1}{2}$ inches. To insure a good and quick braird, suppose that half of this manure is required before the seed is sown, 27 $\frac{1}{2}$ inches of water would require to be directed upon the acre—that is, a quantity of about a whole year's rain on the east coast, and three-fourths of the average fall of the country, should be poured on at one time. How long would this quantity of water be in subsiding, and where are the drains that would convey it away in time, even although assisted by evaporation? The other half of the manure, 27 $\frac{1}{2}$ inches, should perhaps be applied at two different periods of the plant's growth—that is, 13 $\frac{1}{4}$ inches at each time, equal to about a half of the average fall of rain over the country. But along with all this watering, we must remember that the rain has been falling in its wonted quantity, still further retarding the absorbing property of the soil, and testing the conducting power of the drains. This simple statement of the effects of applying a very limited quantity of sewerage water is sufficient to show the impracticability of the scheme, as regards arable land; and if 15 tons of manure are prescribed to the acre, which ought to be to do justice to the crop, the above results would be increased 50 per cent. But if less than the smaller quantity is sufficient for the purpose of manuring any crop on arable land; what is the quantity of sewerage water just necessary to produce a given crop? I visited Mr Harvie's dairy at Hunderd-acre-hill farm, in the neighbourhood of Glasgow, on the 3d of August 1850, to see the mode he has adopted of distributing liquid manure, by means of pipes through which it is propelled by a steam-engine. This was the instance adduced before the Committee of the House of Commons in 1846, of a successful application of liquid manure by means of pipes, by the Metropolitan Sewerage Manure Company, when they had their bill before Parliament.† The cases are not quite analogous, as Mr Harvie applies cow urine directly upon the land. He has, in summer, 400 cows giving milk, which are fed on grass, in pasture, for four hours every day, and in the byres receive twice a-day a dry mash of distillery draff, (1277,) and twice a-day a drink of distillery dreg, (1273,) there called *pot ale*, both at stated hours. The

* *North British Agriculturist*, March 7, 1850; and *Transactions of the Highland and Agricultural Society*, July 1850, p. 332.

† *Report—Metropolitan Sewerage Manure Company—13th July 1846.*

greatest part of the urine is conducted by drains to a large tank, but part of it must be carried away with the dung, which is wheeled into dung-pits, and part poured upon the pasture field. The urine in the tank is kept in motion by means of an agitator, worked by the steam-engine when the pumps are in action. The pumps send the urine to the highest part of the ground, where large reservoirs are erected to receive it, and from which it is conveyed in pipes to certain convenient points, where it rises to the surface, and is distributed over the ground by means of hose-pipes, which extend to great lengths and are removable at pleasure. Although the urine runs fresh into the tank daily, yet it is as old as to be in a state of incipient decomposition, as is evidenced in the reservoirs by the rising of gas bells to the surface, before it is applied to the soil. It must therefore be of considerable strength, and yet cannot be nearly so strong as the liquid manure used in Flanders, where it is applied to the arable land. A tank containing the urine, as it runs from the stables and byres when voided by animals supported on green food, holding 30,000 gallons, is enriched with from 2000 to 4000 rape-cakes of 2 lb. each, to every 1000 gallons, and a large quantity of the contents of privies obtained from the towns, and 2480 gallons of this rich manure are applied to the acre.*

5018. The urine is distributed over grass, turnip land, and garden ground; and as far as I could judge of its effects, I would say that the ground was under-manured, and none of the crops were remarkably good. Such a system seems practicable on a large dairy farm, but not where the command of a large quantity of urine cannot be obtained. I am satisfied that sewerage water could not have produced even so good an effect as the urine, by distribution from pipes.

5019. Of the comparative utility of dung and urine in supplying nitrogen to plants, we have the authority of Liebig for saying, that "the solid excrements of men and animals contain comparatively very little nitrogen," and that the urine of cattle, horses, and sheep, contains far more nitrogen than their solid excrements. "Now," he continues, "as it is evident that the nitrogen of plants and seeds used by animals as food must be employed in the process of assimilation, it is natural to expect that the solid excrements of these animals will be deprived of it in proportion to the perfect digestion of the food, and can only contain it when mixed with secretions from the liver and intestines. Under all circumstances, they must contain less nitrogen than the food. . . . The liquid manure of animals must, on the other hand, be of the highest value with respect to nitrogen, because it contains all or nearly all the nitrogen originally present in the food consumed." Liebig gives a striking instance of the different effects of dung and urine on a wheat crop. "One hun-

dred parts of wheat grown on a soil manured with cow-dung, (a manure containing the smallest quantity of nitrogen,) afforded only 11.95 parts of gluten, and 62.34 parts of amylin or starch; while the same quantity, grown on a soil manured with human urine, yielded the maximum of gluten—namely 35.1 per cent, or nearly three times the quantity. . . . It is obvious," he concludes, "that by collecting both the solid and liquid excrements of an animal fed upon the produce of a certain surface of land, we are enabled to supply to it nearly the same quantity of nitrogen as that contained in the original produce. Thus, we supply to the land a certain quantity of ammonia in addition to that which may be extracted from the atmosphere by the plants growing upon it."† It thus appears, that to deprive dung of the urine which accompanies it, is to render it less valuable as a manure; and although urine, in the form of liquid manure, be more valuable than dung, it is so at the expense of the dung. A farmer who would only employ the urine as a manure, as Mr Harvie does, and dispose of the dung, may enrich his own land, provided he has the command of a sufficient quantity of urine; but he would thereby so much impoverish the land to which the dung he sold would be applied. On a dairy farm, such as Mr Harvie's, such a system may be pursued; but in ordinary farming it seems questionable practice to deteriorate the value of the dung by separating the urine from it into a tank, as may be inferred from the statements of Liebig given above.

5020. *Coal ashes*.—Coal ashes consist in general of lime, often in a state of gypsum, with magnesia, silica, alumina, and oxide of iron, mixed with a variable quantity of bulky and porous cinders, or half-burned coal. Its composition is as follows, according to the nature of the coal:—

	St Etienne. Berthier.	Cantyre. Thomas.
Silica, . . . . .	...	45.5
Alumina, insoluble in acids, 62 }	}	43.9
Alumina, soluble in acids, 5 }		
Lime,	6	3.2
Magnesia,	8	3.3
Oxide of manganese,	3	...
Oxide of sulphuret of iron, 16		1.4
Sulphuric acid, . . . . .	...	1.7
Chlorine, . . . . .	...	0.1
Potash and soda, . . . . .	...	0.3
	100	99.4†

Coal ashes are admirably suited for absorbing any sort of liquid manure, and of first preserving and then imparting it to any crop it may be top-dressed upon. Grass lands derive much advantage from such a top-dressing, and when applied to strong soils, it has the effect of producing a favourable physical change upon them, (2803.)

5021. *Wood ashes*.—"Wood ashes lixiviated

* Radcliff's *Agriculture of Flanders*, p. 39.

† Liebig's *Chemistry in its Application to Agriculture*, 3d edition, p. 50-3.

‡ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 632.

with cold water," observes Liebig, "contain silicate of potash in exactly the same proportion as straw, and that, in addition to the salt, it contains considerable quantities of phosphates. Different kinds of wood ashes possess very unequal value as manure. Thus, the ashes of the oak are of the smallest, those of the beech of the greatest value. Wood ashes from oak contain 4 to 5 per cent of phosphates; those from the beech contain the fifth part of their weight of these salts. The quantity of phosphates in the ashes of firs and pines amounts to from 9 to 15 per cent; the ashes of the poplar contain 16½ per cent, and those of the hazel-nut tree, 12 per cent. With every 100 lbs. of the lixiviated ashes of the beech, we furnish to the soil as much phosphates as are contained in 460 lb. of fresh human excrements. According to the analysis of Saussure, 100 parts of the ashes of grains of wheat contain 32 parts soluble, and 44.5 parts insoluble, or altogether 76.5 parts soluble and insoluble phosphates. The ashes of wheat straw contain in all 11.5 per cent of phosphates. Thus, with every 100 lbs. of the ashes of beech, we furnish to the field phosphoric acid sufficient for the production of 4000 lb. of straw, (calculating its ashes at 4 per cent, according to Saussure,) or for 2000 lbs. of the grains of wheat, (calculating their ashes at 1.3 per cent, according to Saussure.) The dry fruit of the horse-chestnut yields 34 per cent of ashes, possessing a similar composition to the ashes of maize, and of the grain of certain kinds of wheat."*

ON ELECTRO-CULTURE.

5022. Any material that promotes the vegetation of plants may be regarded as a special manure. In this view, electricity, when applied practically to a crop, may be classed amongst the special manures.

5023. That some connection exists betwixt the growth of plants, or the germination of their seeds at least, and the evolution of the electric fluid, has been satisfactorily demonstrated by M. Pouillet, who discovered that positive electricity was given out from plants when germinating, (127.) As a consequence, it has been suggested to render available the influence of the electric agency, in raising plants on a large scale on the fields of the farm. Dr Forster of Findrassie, near Elgin, was the first to draw the attention of agriculturists to this subject, in 1844; and in that year he published the results he obtained in the electro-culture of Chevalier barley, which was increased to 13

quarters, or 104 bushels, an acre; and its straw to about a third more than the usual quantity. Such a result set other experimenters to work, but no one has as yet been able to reap similar advantages from similar experiments as Dr Forster obtained from his; and it is doubtful, in the present state of our knowledge of the subject, that electro-culture will be prosecuted further for a time. Still, it is requisite that I give some account of the means employed for obtaining the assistance of the electricity of the air; but, before doing so, it will be satisfactory to show the relation which exists betwixt the electricity of the air and of the earth—and I cannot do so better than in the words of Mr William Sturgeon of Manchester, who has bestowed much attention to the subject of electricity in all its bearings.

5024. "It may not be out of place to remind those not accustomed to the study of electricity," observes Mr Sturgeon, "that this active element of nature is so universally diffused through every part of the terrestrial creation; that it becomes an occupant of every part of the earth's surface, and of the shell of air that surrounds it. This general definition necessarily leads to the inference that all the various objects which clothe the surface of the earth—such as trees, shrubs, plants, flowers, and crops of every kind—partake of this electric distribution, and that each individual object is possessed of more or less of this extraordinary element—or, in electrical language, that each is possessed of its *natural* share. It must not be understood, however, that this natural distribution confers upon different objects an *equal* share, either in proportion to their magnitude, weight, or shape; but, on the contrary, that each object contains a share peculiar to itself, according to its degree of susceptibility of receiving the fluid, or according to its *capacity*. But whatever may be the quality due to any individual object, under ordinary circumstances, it becomes exquisitely susceptible of disturbance when the circumstances vary, and whether these be of natural or artificial occurrence. A disturbance of the electric fluid, in any body, may be accomplished either by abstractions, additions, or by

* Liebig's *Chemistry in its Application to Agriculture*, 3d edition, p. 184.

merely forcing a part of it to some particular side of the body operated on. In the first condition the body would be *electro-negative*, in the second *electro-positive*, and in the third *electro-polar*. These, together with the *natural electric* condition, would appear to number four distinct electric states or conditions that any body or object may assume, according to the circumstances in which it is placed; but as the terms *positive* and *negative* are expressions which, in a strictly philosophical sense, imply nothing more than the *relative* electric conditions of bodies, any individual body or object may be *positive* to another, whilst at the same time it is *negative* to a third. Hence the only *absolute* electric state that any body can appear in is the *polar*—a condition growing plants must necessarily assume. The various objects which constitute the vegetable clothing of the land are now in precisely the same electric condition, being continually *positive* and *negative* with regard to each other. An oak and an ash tree, for instance, though both in their ordinary or normal electric states, are not endowed with the same degree of electric force, one being *positive* to the other, and, consequently, the latter *negative* to the former. A similar inequality of electric force occurs amongst growing plants and their manures, and even amongst the various elements which constitute the latter, no two of them being precisely alike at the same time. The normal productions of the earth also, as decidedly as those just noticed, display a diversity of electric action amongst themselves, no two of them being found alike. Hence the particles constituting each and every variety of soil are endowed with a peculiar electric force—a circumstance of immense importance in the contemplation of the vegetable physiologist, and carefully connected with all electro-cultural operations.”

5025. “When the electric fluid is in abundance and in motion, it is accompanied by a development of heat which, in some cases, is of sufficient intensity to fuse the most refractory substances. Electricity, like heat, has its *conductors* and *non-conductors*, but in some cases they are different for the two kinds of force. For instance, charcoal is a good conductor of

electricity, but a bad conductor of heat. The metals are the best electrical conductors; but there are many other kinds of matter which rank high in this capacity. Such are trees when full of sap—water, and consequently all growing plants, by virtue of the water they contain. Moist land is also a conductor of electricity. Dry sand is a bad conductor, so is dry mould of every kind; but limestone rock and dry chalk are still worse; and dry air is a worse conductor than any of the rest, though moist air is a tolerably good conductor. When the electric fluid meets with a good conductor, it spreads with rapidity over the conducting surface; but when it meets with an inferior conductor, it has to encounter a resistance which, in some cases, it is unable to overcome; consequently its forces are limited within a certain range of locality.”

5026. “Another grand law of electricity, to be noticed by the electro-cultural physiologist, is the following:—In all cases of electrical disturbance, whether the fluid be in the act of absolute transfer from one body to another, or traversing conducting channels in the character of currents, or spreading itself over surfaces of moist land or other conducting matter, the transmission is uniformly *from the positive to the negative parts*; for in no case can the fluid be transmitted *from a negative to a positive body*, nor from a *negative part to a positive part* of the same body. Hence it is that those parts of the prime conductor of an electrical machine, which are in the act of *receiving* fluid from the revolving glass, are *negative* with respect to the latter, although, at the same time, the remote parts of the conductor be *positive* to all surrounding bodies, and whether they be delivering the fluid as fast as they receive it or not. Therefore the prime conductor is *electro-polar*, under all circumstances, when the machine is at work. Now, as this is a universal law when electric fluid is transmitted from one body or object to another, it follows that the electro-positive state of the air, contiguous to growing plants, causes the latter to become *electro-polar*, even when they are in the act of transmitting fluid to the ground—their upper parts being negative relatively to the roots, whilst the latter, in their turn, are positive to the contiguous manure

and soil, to which they deliver up the fluid—or rather such portions of them as are not retained for the expansion and growth of the plants—as faithfully as the leaves and stems receive it from the air.”

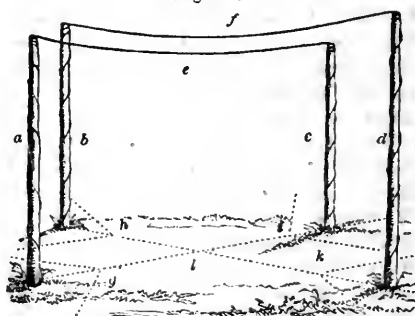
5027. “From this train of reasoning, we are led to some of the most interesting points in vegetable physiology. The electro-polar condition of plants qualifies them in an eminent degree for the performance of those operations which develop electro-chemical phenomena; and what is very remarkable, the laws of this beautiful branch of electricity are rigidly enforced and admirably complied with in the decomposition of carbonic acid gas by their foliaceous parts; for, in this process, the *electro-positive* carbon is drawn to the *electro-negative* poles of the plants, in precisely the same manner as any electro-negative pole, artificially made, would release the carbon from the oxygen, and select it in preference. This remarkable fact, based as it is on the strict principles of electrical action, not only establishes a correct view of the *modus operandi* by which plants are enabled to acquire food through the instrumentality of their foliage, but appears to be well calculated to give a clue to every operation by which vegetables become nourished and elaborate their food, in all the variety of structure they so abundantly and beautifully assume. But as the electro-physiology of the vegetable kingdom has never yet been explored beyond the humble examination of an operation only, any farther remarks on a subject so imperfectly understood would be premature in this place; although no doubt can now remain respecting the influence of electric forces in rearing, adorning, and giving full development to every class of vegetable structure.”

5028. “Contemplations on electro-chemical forces, thus disencumbered of complexity, lead, by easy gradations, to many recondite operations of nature, and to the discovery of those hidden actions by which the ever-varying transformations of matter are accomplished. They are well calculated to afford a clue to those atomic operations which, in silent seclusion, select the appropriate materials, convey them to their destination, and elaborate them in the structure of every vege-

table tissue that is formed within and upon the surface of the land.”

5029. These observations of Mr Sturgeon will enable you to understand the principle upon which the electric fluid may be made to operate on vegetation; and the only thing that now remains to render electro-culture intelligible, is to describe the mode of erecting such an apparatus as shall secure the command of a greater supply of the electric fluid to the crop than it would naturally receive from the atmosphere. Mr Sturgeon's apparatus is simple, and its arrangement may be seen in fig. 437. Dr Forster of Fiudrassie erected his apparatus in the line of the meridian, from an erroneous idea that an electric current is constantly moving round the globe in the direction of E. to W. In these latitudes, the E. winds prevailing in the spring, and the W. winds in summer, Mr Sturgeon erects his apparatus in the direction of N.E. and S.W., and N.W. and S.E., in order that the entire apparatus may receive those winds as near to the right angle as they can. The component parts of the apparatus consist of poles *a b c d*, fig. 437, which should be

Fig. 437.



ELECTRO-CULTURE APPARATUS.

fixed at least 15 feet above the ground, and they may be of any sort of wood, and seasoned or not. Young larch trees would form good poles for the purpose. The pole *c* is set N.E. of *a*, and *d* is S.E. of *b*. The tops of the poles *a* and *c* are connected by the wire *e*, and those of *b* and *d* by the wire *f*; and as one wire should be not less than 9 inches above the other, the poles which bear it should be raised as high above the other poles. The wires are twisted round the poles and brought down into the ground, to connect with the sys-

tem of wires under ground. The under ground wires connect the poles in the same manner as those above ground; the dotted wire *g i* connecting the poles *a* and *c*, and *k h* connecting *d b*. In order to spread the fluid over a larger surface, collateral wires are made to diverge at right angles from each side of the principal wires *g*, *h*, *i*, and *k*. The ground wires should be sunk at least 3 or 4 inches under the surface, that the fluid may be the more easily diffused by the moisture of the ground. The wires should be of copper, because of its superior conducting character, and its capability of withstanding the damp air and moist ground. The upper wires should be elevated as high as practicable; and as tall trees are conductors of electricity, the apparatus should not be erected near trees. Such an apparatus would answer for a space included within 50 yards square; but should the poles be placed at a much greater distance, the wires will be apt to stretch and bend down from their own weight, on which account it would be necessary to place another pole at the centre of bisection *l* of the ground and upper wires. The apparatus should be erected early in spring, immediately after the crop has been sown—and it may be erected on grass land as well as among the cereal crops; and every repetition of the apparatus of the above dimensions may be made to comprehend any extent of ground desired.

5030. Since it matters not whether the ground wires receive the electric fluid by means of the upper wires or the poles, it occurs to me to suggest that metallic rods might be used instead of the wooden poles, and dispense with the upper wires altogether. A few sharp points would convey abundance of electricity to the rods or pillars. But perhaps the cost of these rods would be more than that of the poles and wires, and any such difference is a consideration for economy.

5031. Mr Sturgeon erected, in 1845, such an apparatus on a grass plot in the Botanic Garden of Manchester; but no perceptible influence on the grass was known to occur. He erected another on the farm of Didsbury on barley and oats, the third crop from the fallow one; and “the ridge of oats, both within the under-

ground wire and exterior to it at the ends of the enclosed plot, was much taller, had stronger stems and blades, and of a far deeper green colour than any other plot of oats on the field.” The influence was perceptible on the crop as far as the fourth ridge *westward*, and exterior to the wires. As to the barley, “the ridge *within* the wire, even on those parts of it exterior to the plot enclosed, was the finest barley in the field; but the colour was only a mere shade deeper than that of the other parts of the crop. The first ridge *outside* the wire was obviously the next best; but the distinction here was nothing like so finely marked as in the oats.” The straw of the oats was 6 inches taller under the influence of the apparatus than that beyond it; and although the grains were in no respect superior, the numbers of them on each stalk averaged 50, while the rest of the field only averaged 35. The barley also showed a superiority, but not much. The apparatus erected in Sir Thomas Trafford’s field of oats, sown on mossland not thoroughly dried, gave a greater length of straw of 10 inches, in the early period of its growth; but at harvest the entire crop was a fine one, measuring 7 feet in length. Within the wires a splendid crop of thistles had sprung up. At Kirby Lonsdale, the apparatus was erected on a green field, and the result may be best appreciated when described in the emphatic provincial style of Cumberland, by William Muckald, one of the hinds,—“Wy, I niver sa t’ like in o me life; it beat o t’ other eet field far enough. John Hodgson help’d ta maa ’t, en when we cam tet thiek spot, he sed, ‘dam t’ wires, t’ gerss is sa thiek I can hardly maa t.’ En I ’s sure it capt owgt et iver I saa; that it did.” At Casterton Hall, the apparatus produced “no improvement; or, if any, very slight.”

5032. The conclusions that may be legitimately drawn from the use of electric wires in cultivation are, that in cold, dry easterly winds, the ground becomes so dry and hard that, although the air be charged with the electric fluid, the dry ground can neither receive nor distribute it: that when the air is dry over the crop, it offers a considerable resistance to the dispersive tendency of the fluid, so that the points of the leaves and stems of the growing crop cannot obtain sufficient quantity of

the fluid to stimulate them beyond ordinary vegetation; and the only part of the crop that does receive it in excess is that immediately round each pole: that genial showers, laden with electric matter, soon saturate the land with moisture, rendering it a good conductor, and supply it abundantly with the electric stimulus; and that moist air, losing its insulating quality, becomes more uniformly charged with the electric fluid to a great height above the surface of the land, and yields it without measure to the pointed and sharp-edged leaves of the corn and grass, as well as other conductors more elevated in their vicinity.*

5033. I do not suppose that electro-culture can be extensively practised, even if experience should prove it to be beneficial, because it cannot be prosecuted near trees with any effect; and the trouble and expense of putting up, taking down, and repairing the apparatus every year, is attended with more inconvenience than can be followed out as a system. To a limited extent, however, it does seem suited to practice. It might promote the growth of a patch of turnip seed, (2476,) or of a small field of clover seed, (4379,) or a part of the potato or turnip crop. It might also prove useful around gardens.

ON THE RATIONALE OF THE APPLICATION OF SPECIAL MANURES.

5034. The rationale of the application of the special manures is simple, if the views propounded of their action on plants be correct. You have already seen that every plant is made up of two states of matter, the one organic, the other inorganic, (198.) The organic portion is said to be taken by the plant from the atmosphere alone, because its elements, oxygen, hydrogen, nitrogen, and carbon exist in the atmosphere in a free state. It is not supposed, however, that plants derive their nitrogen from the nitrogen as it exists in the atmosphere, but in the state of ammonia. The nitrogen of the air is considered necessary only as a diluent for the oxygen, and its character of inactivity

precludes it from being acted on by the organs of plants.

5035. Liebig's idea is, that as hydrogen, oxygen, nitrogen, and carbon, are liberated in the decomposition of animal matter in the soil, and as hydrogen has a predominating affinity for nitrogen, ammonia is formed in the soil, in which the roots of plants receive it in both the gaseous and saline states, the latter being formed by the union of ammonia with carbonic acid, generated by carbon and oxygen, and easily soluble in water; but while the roots of plants thus receive ammonia as it is formed in the soil, part of the ammonia escapes into the atmosphere, and returns to the soil with the rain, for the use of plants—the quantity received directly from the soil being greater than that brought back again by the rain. The inorganic constituents of plants are derived directly from the soil.†

5036. This is a very probable mode by which plants receive their nitrogen, an essential element of their existence; but if it be strictly true, it seems to a practical mind an over-straining of the subject, to press upon farmers the absolute necessity of preventing any escape of ammonia from their dung heaps. It appears that plants receive more ammonia from the soil than from the atmosphere; and as the atmosphere supplies nearly all the ammonia the cereal crops require, it is no stretch of improbability that the soil contains as much as they do require. If these inferences be correct, the necessity for incurring the expense and trouble of using the means of preventing the escape of ammonia into the atmosphere is not very apparent.

5037. Mulder's views of the manner in which the ammonia of the manures is produced in the soil, are these:—That several organic constituents of the soil—namely, the humic, ulmic, geic, crenic, and apocrenic acids—after being combined with ammonia, are taken up in solution by the roots and assimilated by plants, on the ground that the compounds which these acids form with ammonia are very

* *Journal of Agriculture*, March 1846, 271-96.

† Liebig's *Chemistry in its Application to Agriculture*, 3d edition, p. 41-59.

readily soluble in water, and because several of these acids possess polybasic properties, by which they are enabled to form combinations with potash or soda, ammonia, lime, magnesia, and oxide of iron, in which several of these bases are present at one and the same time: that ammonia is formed in the soil by the combination of the nitrogen of the air there with hydrogen in the nascent state, as liberated during the decay of vegetable and animal substances in the soil.

5038. Dr Fromberg thus explains Mulder's views of the action of plants upon manures in the soil: "In whatever way the decay of the organic substances present in the soil be conceived—the main products being humic, ulmic, and crenic acids—there will always be a large excess of hydrogen, which, being in the nascent state, has all its properties unweakened. It is, moreover, set free amidst a decaying and porous organic substance, with a limited access of air, and at a low temperature—conditions essential to effect the production of ammonia, and to prevent that of nitric acid, which latter substance is commonly found in the heat of the tropical regions. The decaying organic matter sets free carbon, hydrogen, oxygen, and a little nitrogen. The carbon, obeying its strongest tendency in this condition, forms carbonic acid, in so far as it can find oxygen enough present in the air, which is continually circulating through the porous soil. The small remainder of carbon, if a sufficiency of oxygen cannot be procured, will combine with part of the hydrogen; and hence the quantity of carburetted hydrogen in marshy places and stagnant waters. The remainder of the hydrogen takes the nitrogen, simultaneously liberated from the plant, and also from its intimate mixture with the nitrogen in the atmospheric air; and thus ammonia is formed. This ammonia, the extraordinary affinity of which for humic, ulmic, and crenic acids is very well known, combines immediately with part of the decaying substances, when still in a state of humus, either extracting or producing humic and ulmic acids, with which it forms humate and ultimate of ammonia, so extremely soluble in water, and fit for progressive decomposition within

the cellular tissue of the plants. Now, it is evident from this, that, as the said production of humic acid is going on gradually, there are only small quantities present at the same time in the soil, that which is formed being instantly taken up by the roots. There is a continual formation and absorption of it; and thus, though the liquid is always cold and weak, and so adapted to the tender extremities of the roots, it is *constantly* present, and so a sufficient and nourishing supply is present whenever required. The beautiful connection which this theory constitutes between the production and use of ammonia and the humic acid in the soil is evident, and certainly not the least of the advantages of the theory itself. It agrees remarkably well with the great rule of nature, that there is a close relation of causation between any two products whose presence is necessary to each other. The experiment of Mulder, showing the luxuriance of plants grown in a mixture of charcoal, ashes, and ulmic acid, superior to those grown in mere charcoal and ashes, and, at the same time, the larger quantity of ammonia *produced* and assimilated by the former, apparently tends to solve two problems at once."*

5039. In whatever way those organic constituents of plants, the nitrogen and carbon, are derived, there can be little doubt but that their inorganic constituents are derived from the mineral ingredients of the soil, which, however, must first assume that state in which they are most easily dissolved by water, as a condition in which the roots are enabled to absorb them for use. While describing the cultivation of each plant, I have specified its inorganic ingredients, that they might be directly referred to when I came to speak of the use of special manures; the theory being, that the knowledge of the composition of plants, and of the soil in which they best grow, indicates at once the exact composition of the special manure which should best promote the growth and maturing of the plants. From the vast variety in the proportions of the component parts of different plants and soils, it seems almost impossible to concoct a special manure that shall produce a given

* *Journal of Agriculture*, October 1845, p. 50.

result in each case; but it is evident, where the composition of both plant and soil is unknown, nothing but chance can guide the application of a special manure. At any rate, until the composition of all the cultivated plants, and of the different characters of soils, have been ascertained, no fixed formula of particular manures can be prescribed with certainty.

5040. Much of late years has been done, and is now doing, by chemists, to ascertain the composition of the cultivated plants at every important period of growth, and a great deal more has yet to be accomplished. But it is feared that the proportions of the mineral ingredients of those which have been already subjected to analysis do not exist in the plant in the state the analyses represent them to us, nor are best suited for absorption into the plant. The method of obtaining the mineral constituents of the plant by burning, seems to imply that all the inflammable mineral substances must have been destroyed by the fire along with the large vegetable portion. Hence the quantity of sulphuric acid is probably always represented below the mark; and such a result alters the proportion which the rest of the ingredients bear to one another. The only way of practically remedying such a defect is to apply a larger quantity of each ingredient than the apparent wants of the plant indicate. Each inorganic matter is certainly essential to the wellbeing of a plant; and although its proportion may vary relatively to the other ingredients, it takes its place according to some fixed law.

5041. The analysis of soils is a tedious and dilatory process, and ere every variety can be analysed, ages must pass away. But soils indicate distinctive characters which cannot be mistaken, at least by practical agriculturists, (332;) and were a few minute analyses of each class made, from specimens selected from localities famed for the kinds of crops which they raise, a standard for each class might be established which might answer all practical purposes for reference. Dr Thomas Anderson of Edinburgh, Chemist to the Highland and Agricultural Society, has

commenced such an investigation, and has already published some interesting particulars on the composition of wheat clays.*

5042. Possessing such analyses of plants and soils, agriculture would be made comparatively an easy art, as appears from these observations of Dr Fownes,—“If we were in possession of a set of analyses of sufficient completeness and extent, both of the proximate organic and mineral constituents of all such substances, the proportion of water, and other things—this information, combined with a knowledge of the gross weight of such crops, raised on a given space of ground, would enable us to manage matters that the nature of the food and the extent of its supply should be duly apportioned to each class of plants; and that, instead of annually loading our lands with manures, frequently at a great expense, whose mode of operation we little understand, and in which it may happen that those very substances wanted are deficient, while others, already redundant, are supplied in injurious excess, we shall be able to proceed in a more systematic manner, and give the quantity and kind of food required, and no more.” †

5043. I have no doubt but that much of the manure laid upon the land is given by farmers without a matured idea of what its constituents should produce; and had farmyard manure been other than a material containing all the ingredients of the plants raised on a farm, many more failures than have actually occurred in crops would have been experienced by the general body of farmers. But however easy it may be to apply manures, after the component parts of plants and soils shall be known, as long as the limited knowledge on those particulars exists, manures must continue to be applied in the same manner they have hitherto been, with such gradual improvement as the light of progressive investigation and inquiring experiments shall direct. In the existing state of knowledge, it seems incredible to the practical farmer that, after all the expense he has incurred in purchasing the best constructed implements, and the trouble he has bestowed on working the land with them,

* *Transactions of the Highland and Agricultural Society*, July 1850, p. 281.

† *Journal of English Agricultural Society*, vol. iv. p. 535.

to bring it to the best degree of tilth suited to the particular crop it is destined to grow—and after the labour of preparing the large quantities of manure which he directly lays upon the land, and the cost which he cheerfully expends in purchasing auxiliaries to his home manure, to be used over and above as top-dressings on the growing crop—after all this toil has been bestowed over a large proportion of the year, it seems incredible to him when he is told that it only secures a proportion seldom exceeding 5 per cent of the crop he has reaped, while the other 95 per cent has been derived from the atmosphere alone—an element which he knows he can have at all times without stint or trouble. I am sure that every practically-minded man will receive such intelligence with incredulity; and if the soil is only capable of affording the mineral ingredients of the plants, well wrought and well supplied with manure as it may be, the farmer's exertions must be valued at a small amount; and hence the consideration arises whether the same, or even greater results, may not be attainable with less exertions than have hitherto been bestowed upon the land. Let chemists decide this point, and in the mean time the farmer will conduct his practice according to the dictates of his own judgment.

5044. Out of the uniform mass of farm-yard manure hid under the ground, with the addition of special ones, plants have the power of converting the materials they receive into the ingredients which the functions of their particular parts elaborate. Those materials act on plants at different times, and in different parts of the same plant, according to their respective natures, as thus propounded by Professor Johnston:—"They all form, more or less constantly and abundantly, a portion of the fixed and solid matter of the plant, taken as a whole. They may not be found in any one part of the plant, when separated carefully from the rest; but in the solid parts of the plant, taken as a whole, they are all and always to be met with. When thus deposited, they become for the most part dormant as it were, and for the time cease to perform an active chemical function in the general growth, though, as vessels or cells, they may still perform a mechanical function.

5045. "They undergo various chemical changes in the interior, chiefly while circulating or contained in the sap, by which changes they are prepared and fitted for entering, when and where it is necessary, into the composition of the solid or fixed parts of the plants. Thus the starch of the seed is changed into the soluble dextrin and sugar of the sap of the young plant, (3509.) and then again into the insoluble cellular fibre of the stem or wood, as the plant grows; and finally into the insoluble starch of the grain, as its seed fills and ripens.

5046. "They each exercise a chemical action, more or less distinct, decided, and intelligible, upon the other elementary bodies, and the compounds of them which they meet with in the sap of the plant. In regard to some substances, such as potash and soda, the sulphuric and the phosphoric acids, this last function appears to be especially important. These substances influence all the chemical changes which go on in the interior of the plant, and which modify or cause its growth. The same is true of the nitrogen which the plant contains. This elementary body, in the form of albumen, or some other of the numerous protein compounds which occur in the sap, presides over or takes part in almost every important transformation which the organic matter of the living vegetable undergoes. Thus it is always abundantly present where the starch of the seed or of the tuber (as in the grain of wheat or of the potato) is dissolved and sent up to feed the young shoot; and again when the soluble substances of the sap are converted into the starch of the grain, of the tuber, or of the body or pith of the tree, one or other of the protein combinations is always found to be present on the spot where the chemical change in transformation is going on.

5047. "Besides these general functions, the several substances found in plants exercise also special functions in reference to vegetable life and growth. Thus *nitrogen* is most abundant in the sap of young plants, takes part in most of the changes of organic compounds which go on in the sap, and fixes itself, as the plant approaches maturity, in greatest abundance in the seeds and in the green leaves.

5048. "*Potash* and *soda* circulate in the sap, influence chemical changes very much, and reside or fix themselves most abundantly in green and fleshy leaves, and in bulbous roots.

5049. "*Sulphuric acid* is very influential in all chemical changes, is found in most cases in those parts of the plant in which potash and soda abound, and deposits a portion of its sulphur wherever the compounds of nitrogen form a notable part of the substance of the plant.

5050. "*Phosphoric acid* exercises also much influence over the chemical changes of the sap, and finally fixes itself in greatest abundance in the seeds and other reproductive parts of the plant.

5051. "*Lime* is very important to healthy vegetable growth, as practical experience has long testified. Among other duties, it appears to accompany the phosphoric acid in the sap of plants, and to deposit itself in combination with organic acids (oxalic, &c.) in the leaves and bark, and with phosphoric acid in some seeds and roots.

5052. "*Magnesia* appears also to attach itself very much to phosphoric acid in the sap, and fixes itself in combination with the acid principally in the seed.

5053. "*Chlorine*—the chemical function of this substance in the sap is less understood even than that of the other substances above mentioned. It exists chiefly in combination with soda, and is much more abundantly present in some plants, and in some parts of plants, than in others. Though, as I have said, its immediate chemical function in the plant is not understood, it forms a most important constituent of the plant, in so far as the after uses of vegetables in the feeding of animals is concerned.

5054. "*Silica* exists in the sap in a soluble form, and deposits itself chiefly in the exterior portions of the stems and leaves of plants. It is supposed there to serve as a defence to the plant against external injury, and to give strength to

the stem, in the case of the grasses and corn-yielding plants; but what chemical functions it performs, if any, in directly promoting vegetable growth, we can scarcely as yet even venture to guess.*

5055. You thus perceive that about 11 mineral ingredients are removed from the soil by the crops usually cultivated on a farm. But of these, four—silica, alumina, magnesia, and iron—are usually found in abundance in all ordinary soils, the peaty, the sandy, and the chalky being the exceptions, and all these are limited in extent. The lime is supplied to the soil as a necessary ingredient in the prosecution of good husbandry, so that only 6 substances require to be replaced which the crops carry off, and these are potash, soda, magnesia, phosphoric acid, sulphuric acid, and chlorine. Let us therefore ascertain, from some authority, how much of these ingredients are removed from the soil by a single ordinary crop of each kind.

5056. *Wheat*.—Mr Prideaux states that the following quantities are removed from an acre of soil by a crop of wheat, of 25 bushels of grain, and 3000 lb. = 1 ton, 6 cwt. 88 lb. of straw, a moderate crop:—

	By the grain.		By the straw.		Total.
	lb.	lb.	lb.	lb.	
Potash, . . .	7.15	22.44	0.29	29.59	
Soda, . . .	2.73	0.29	0.29	3.02	
Magnesia, . . .	3.63	6.89	0.29	10.52	
Phosphoric acid,	15.02	5.54	0.29	20.56	
Sulphuric acid,	0.07	10.49	0.29	10.56	
Chlorine, . . .	0.00	1.97	0.29	1.97	
	28.60	37.62			

Gross weight to be returned to an acre, . . . 76.22

5057. *Barley*.—The quantities removed from the acre by a crop of 40 bushels of barley, and 2650 lb. = 1 ton, 3 cwt. 74 lb. of straw, are as follows:—

	By the grain.		By the straw.		Total.
	lb.	lb.	lb.	lb.	
Potash, . . .	7.24	10.29	0.29	17.53	
Soda, . . .	4.32	0.92	0.29	5.24	
Magnesia, . . .	3.97	5.25	0.29	9.22	
Phosphoric acid,	20.74	5.02	0.29	25.76	
Sulphuric acid,	0.05	2.66	0.29	2.71	
Chlorine, . . .	0.02	1.58	0.29	1.60	
	36.34	25.72			

Gross weight to be returned to an acre, . . . 62.06

5058. *Oats*.—A crop of 50 bushels of oats, and 3800 lb. = 1 ton, 13 cwt. 104

* Johnston's *Experimental Agriculture*, p. 9-11.

lb. of straw, take from the acre of soil the following quantities:—

	By the grain.		By the straw.		Total.
	lb.	lb.	lb.	lb.	
Potash and soda,	10.88	64.78	8.95	75.66	
Magnesia,	3.52	8.95	12.47	16.47	
Phosphoric acid,	14.48	5.38	19.86	24.84	
Sulphuric acid,	5.28	9.95	15.23	20.51	
Chlorine,	0.35	8.51	8.86	11.71	
	<u>34.51</u>	<u>97.57</u>		<u>132.08</u>	

Gross weight to be returned to an acre, . . . 132.08

5059. *Beans*.—Beans, of a crop of 25 bushels of grain, and 2800 lb. = 1 ton, 5 cwt. of straw, carry off, from an acre of the soil, these quantities:—

	By the grain.		By the straw.		Total.
	lb.	lb.	lb.	lb.	
Potash,	13.60	90.21	103.81	103.81	
Soda,	4.30	2.72	7.02	7.02	
Magnesia,	3.15	11.38	14.53	14.53	
Phosphoric acid,	15.20	12.32	27.52	27.52	
Sulphuric acid,	0.40	1.85	2.25	2.25	
Chlorine,	0.30	4.35	4.65	4.65	
	<u>36.95</u>	<u>122.83</u>		<u>159.78</u>	

Gross weight to be returned to an acre, . . . 159.78

5060. *Red Clover*.—An ordinary crop of red clover takes these quantities from an acre of soil:—

	lb.
Potash,	26.70
Soda,	7.07
Magnesia,	4.48
Phosphoric acid,	8.80
Sulphuric acid,	5.98
Chlorine,	4.86

Gross weight to be returned to an acre, . . . 57.89

5061. *Potatoes*.—A crop of 8 tons of potatoes, and 1000 lb. = 8 cwt. 104 lb. of tops, will remove from an acre of the soil the following quantities:—

	By the tubers.		By the tops.		Total.
	lb.	lb.	lb.	lb.	
Potash,	222.56	50.44	273.00	273.00	
Soda,	7.44	29.27	36.71	36.71	
Magnesia,	21.08	12.76	33.84	33.84	
Phosphoric acid,	50.20	13.72	63.92	63.92	
Sulphuric acid,	54.43	12.38	66.86	66.86	
Chlorine,	17.04	22.19	39.23	39.23	
	<u>372.80</u>	<u>140.76</u>		<u>513.56</u>	

Gross weight to be returned to an acre, . . . 513.56

5062. *Turnips*.—A crop of 20 tons of turnips, and 1850 lb. = 16 cwt. 58 lb. of tops, will carry off these quantities from an acre of soil:—

	By the bulbs.		By the tops.		Total.
	lb.	lb.	lb.	lb.	
Potash,	142.66	88.82	231.48	231.48	
Soda,	17.31	16.76	34.07	34.07	
Magnesia,	18.16	9.58	27.74	27.74	
Phosphoric acid,	25.77	28.80	54.57	54.57	
Sulphuric acid,	46.24	38.81	85.05	85.05	
Chlorine,	12.24	49.75	61.99	61.99	
	<u>262.38</u>	<u>232.52</u>		<u>494.90</u>	

Gross weight to be returned to an acre, . . . 494.90

5063. *Cabbages*.—A crop of cabbage 20 tons, 8 cwt. 4 lb. carries off from an acre of the soil these quantities:—

	lb.
Potash,	105
Soda,	184
Magnesia,	54
Phosphoric acid,	112
Sulphuric acid,	192
Chlorine,	52

Gross weight to be returned to an acre, . . . 699

5064. It will be observed from these results, the much larger quantity which the green crops, potatoes, turnips, and cabbages, remove of the mineral ingredients from the soil, compared with that which the grain crops, wheat, barley, and oats, carry away—the proportion being 4 times as much. This is a result which observation alone would not have anticipated, because the expanded area of foliage which the green crops present to the air, would lead us to expect that their nourishment is derived more from the atmosphere than the soil; and, on the other hand, the cereal plants, having narrow leaves, should depend more upon the resources of the soil than they seem to do. But this apparent anomaly may perhaps be explained in this manner:—The green crops weighing so very much heavier than the grain ones, from three to eight times, they ought, as a matter of course, to take a larger quantity of mineral ingredients from an acre of soil; and as all plants require to absorb a large quantity of water daily, in order to keep the saline ingredients within them in a constant state of solution, it seems necessary that the green crops should be provided with a large system of leaves to enable them to draw, both through the roots and from the atmosphere, the large supply of water which they require to have in order to hold in constant solution the larger quantity of the saline ingredients they contain.

5065. Now let us see by what means these respective ingredients are to be returned to the soil. “The best supply of phosphoric acid for the farmer,” observes Mr Prideaux, “will be bone-dust, because the fossil phosphates, such as the coprolites, though cheaper, are so uncertain in strength that he would never know how much he was using. Genuine bone-dust will contain about 25 per cent of phosphoric acid, and will require one-half its weight of

salt, and one-third its weight of strong sulphuric acid to soften and render it soluble; and these will also more than supply the sulphuric acid, the soda, and chlorine. If the lime used on the land does not contain sufficient magnesia, it may be put in at very small cost, either in crude sulphate of magnesia, Epsom salts, or in the bittern residual liquor of the salt-works. The potash is the most difficult material to procure economically. Foreign pearl ash contains about 50 per cent, and is rather dear. Foreign potash is a little cheaper and stronger, 60 per cent, but not so readily procurable dry. Wood-ashes, which contain about 3 per cent of potash, vary also, and are not easy to get sound and genuine. Crushed granite, averaging 7 per cent, digested with lime, although the materials are inexhaustible, is not yet in the market."

5066. The grain and the straw of the wheat crop enumerated above, containing 20½ lb. of phosphoric acid, will require 80 lb. of bone-dust, 40 lb. of salt, and 27 lb. of strong sulphuric acid, and which will also more than supply the soda, the sulphuric acid, and the chlorine. Of brown sulphuric acid 40 lb. will be required. The 29½ lb. of the potash, of which three-fourths is in the straw, may be obtained from 50 lb. of potash, or 60 lb. of pearl ash, or 5 to 10 cwt. of common wood-ashes, or from 12 to 16 cwt. of crushed granite. Half a hundredweight of crude sulphate of magnesia will supply 10 lb. of magnesia.

5067. Thus, for every

1 lb. of phosphoric acid, we have to take .	{ 4 lb. of bone-dust, 2 lb. of salt, 2 lb. of sulphuric acid. the soda, the sulphuric acid, the chlorine.
Clearing also .	
1 lb. of potash, we have to take .	{ nearly 2 lb. of foreign potashes, or fully 2 lb. of pearl ash.
1 lb. of magnesia, we have to take .	
	{ 5 lbs. of crude Epsom salts, or 1 gallon of salt-works bittern.

5068. Hence, the above crops will require these ingredients per acre :—

	Pearl ash.	Common salt.	Bone-dust.	Sulphuric acid.	Crude Sulphate of magnesia.
Wheat, . . .	lb. 60	lb. 40	lb. 80	lb. 40	lb. 50
Barley, . . .	35	50	100	50	40
Oats, . . .	100	40	80	40	60
Beans, . . .	208	55	110	55	70
Clover, . . .	54	18	36	18	22
Potatoes, . .	546	128	256	128	170
Turnips, . . .	462	110	220	110	140
Cabbages, . .	210	224	448	224	270

5069. *Wheat.* The cost of raising wheat with these ingredients on an acre will be as follows, according to the prices attached to the list of the articles enumerated in (4974.)

60 lb. of pearl ashes, at 36s. per cwt.,	L.0 19 3
40 .. salt, at 1s. 3d. per cwt.,	0 0 5½
80 .. bone-dust, at 2s. 6d. per bushel,	0 4 7½
40 .. sulphuric acid, at 3d. per lb.,	0 2 6
50 .. magnesia, at 10s. per cwt.,	0 4 5½
	<hr/>
	L.1 11 3½

5070. *Barley.* The cost of barley per acre is as follows :—

35 lb. of pearl ashes, at 36s. per cwt.,	L.0 11 3
50 .. salt, at 1s. 3d. per cwt.,	0 0 6½
100 .. bone-dust, at 2s. 6d. per bushel,	0 5 9½
50 .. sulphuric acid, at 3d. per lb.,	0 3 1½
40 .. magnesia, at 10s. per cwt.,	0 3 6½
	<hr/>
	L.1 4 3

5071. *Oats.* The oats cost this per acre :—

100 lb. of pearl ashes, at 36s. per cwt.,	L.1 12 1½
40 .. salt, at 1s. 3d. per cwt.,	0 0 5½
80 .. bone-dust, at 2s. 6d. per bushel,	0 4 7½
40 .. sulphuric acid, at 3d. per lb.,	0 2 6
60 .. magnesia, at 10s. per cwt.,	0 5 4
	<hr/>
	L.2 5 0½

5072. *Beans.* The cost of the beans per acre is as follows :—

208 lb. of pearl ashes, at 36s. per cwt.,	L.3 6 10½
55 .. salt, at 1s. 3d. per cwt.,	0 0 7½
110 .. bone-dust, at 2s. 6d. per bushel,	0 6 4½
55 .. sulphuric acid, at 3d. per lb.,	0 3 5½
70 .. magnesia, at 10s. per cwt.,	0 6 5
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	L.2 3 5½

5073. *Clover.* The red clover cost per acre this :—

54 lb. of pearl ashes, at 36s. per cwt.,	L.0 17 4½
18 .. salt, at 1s. 3d. per cwt.,	0 0 2½
36 .. bone-dust, at 2s. 6d. per bushel,	0 2 1
18 .. sulphuric acid, at 3d. per lb.,	0 1 1½
22 .. magnesia, at 10s. per cwt.,	0 1 11½
	<hr/>
	L.1 2 8½

5074. *Potatoes.* Potatoes cost this amount per acre :—

546 lb. of pearl ashes, at 36s. per cwt.,	L.8 15 6
128 .. salt, at 1s. 3d. per cwt.,	0 1 5
256 .. bone-dust, at 2s. 6d. per bushel,	0 14 10½
128 .. sulphuric acid, at 3d. per lb.,	0 8 0
170 .. magnesia, at 10s. per cwt.,	0 15 2
	<hr/>
	L.10 14 11½

5075. *Turnips.* Turnips cost thus much per acre :—

462 lb. of pearl ashes, at 36s. per cwt.,	L.7 8 6
110 .. salt, at 1s. 3d. per cwt.,	0 1 1½
220 .. bone-dust, at 2s. 6d. per bushel,	0 12 7
110 .. sulphuric acid, at 3d. per lb.,	0 6 10½
140 .. magnesia, at 10s. per cwt.,	0 12 6
	<hr/>
	L.9 1 7½

5076. *Cabbages.* And the cabbages cost this per acre :—

210 lb. of pearl ashes, at 36s per cwt.,	L.3	7	6
224 .. salt, at 1s. 3d. per cwt.,	0	2	6
448 .. bone-dust, at 2s. 6d. per bushel,	1	6	0½
224 .. sulphuric acid, at ¾d. per lb.,	0	14	0
270 .. magnesia, at 10s. per cwt.,	1	4	1½
	<hr/>		
	L.6	14	2

5077. These are the quantities and cost per acre of the mineral ingredients required to raise the crops enumerated above, and the quantities are understood to be as much as would suffice for them to be substituted for farmyard dung; but as farmyard manure contains all these ingredients, besides those which were supposed to be supplied by the soil itself, it is better husbandry to afford to the soil as much of farm manure as can be spared from the dunghills of the farm, or procured elsewhere, and to employ the special manures as auxiliaries to it; and confidence may be reposed in them possessing properties which will secure a uniformity in the growth of the crops, year after year, which the precariousness of the seasons is apt to interfere with when farmyard dung is employed alone. The farmyard dung supplies a sufficient proportion of nitrogen, which excites growth and forms the most strengthening constituent of the food of animals, and also of carbon which is requisite to give the crops firmness. It is said that the roots of plants do not absorb carbonic acid, and perhaps not directly; but as they absorb large quantities of water, and water is seldom or never found devoid of carbonic acid, the body of the plant cannot fail to obtain carbon through the instrumentality of the roots. The experiments of M. Gazzari, tend to prove that roots naturally exercise, in their contact with solid organic matter, an incontestible absorbent action in imparting solubility; and these observations of M. Boussingault are founded on probability, that "plants possibly draw from the atmosphere more than agriculturists commonly suppose; and that the soil furnishes, independently of saline and earthy substances, a proportion of organic matter larger than certain physiologists admit. There is every reason to believe, from what I could learn respecting guano, during my so-

jour on the coast of Peru, that the greater part of the azotised principles of plants originates in the ammoniacal salts which exist or are formed in the manure."

5078. It would seem that wheat and grass require the most nitrogen of any of the crops; wheat appears to require five times more than it contains, and with a deficient supply of this element, it yields poorly both in quantity and quality. With plenty of nitrogen, especially in the form of liquid manure, rye-grass, and particularly Italian rye-grass, has produced large crops, up to 50 or 60 tons on the acre in a year.* The value of the saline ingredients in procuring the nitrogen from the atmosphere is thus asserted by Boussingault: "Such is their ascertained influence, that tobacco, barley, and buckwheat sown in soils absolutely without organic matter, but containing saline substances, and only moistened with distilled water, produced perfect plants, which flowered and fruited, and yielded ripe seeds. Whence it follows, that the presence of saline matter favours remarkably the assimilation of the azote of the atmosphere during the act of vegetation."†

5079. Upon the whole subject of special manures, the rationale of their application may be based upon the certainty of the fact, that a large produce will be obtained, if we only return to the soil the mineral constituents of the crops we cultivate, in combination with nitrogenous substances, and the materials should be in a state to become fit for assimilation by plants.

ON THE ROTATION OF CROPS.

5080. Experience has demonstrated, that one crop after another of the same kind greatly reduces the fertility of all classes of soils. This conclusion might be drawn from reason as well as experience, since it is reasonable to suppose that crops of the same kind take the same sort of food out of the same kind of soil. Experience has also demonstrated, that one crop after another, of a different kind, does not materially reduce the condition of

* *Gardeners' Chronicle*, 2d December 1848.

† Boussingault's *Rural Economy*, p. 454 and 490—Law's translation.

soils. This deduction, then, seems fair—that the condition of the soil is best maintained by taking different crops after one another; and, as every crop, though of different kind, and deriving support from the soil, assists in exhausting it, a limit must be put to the number of crops that should follow one another. Accordingly, in practice, a limit is placed on the number of crops taken in succession, of whatever kind, and this number and succession is called a *rotation* of crops.

5081. Though all crops derive support from the soil, one kind appropriates food in a different degree to another, and even the same crop takes food in different quantities, according to the state its product is allowed to proceed. In practice, different crops are cultivated for very different purposes. One class is cultivated for their *seed*, called corn or grain crops—such as wheat, rye, barley, and oats; in which class may be placed beans and pease, which, although cultivated for their seed, their straw and habits differing, take a different sort of food. Other kinds are cultivated for their roots and leaves, and are therefore called green crops, such as turnips, potatoes, clover, tares, &c.

5082. Every plant that grows ripened seed taxes the soil more strongly for its support than that which only produces leaves and bulbs. Hence the cereal grains tax the soil more than clover or turnips; and yet if green crops are allowed to mature their seed, they tax the soil even more than the cereal grains, since, being biennial, they are the longer time dependent for support.

5083. Practically we might arrange the cultivated plants in the order of their probable power of exhausting the fertility of the soil in this manner. The cereal grains, perhaps, in this succession—wheat, oats, barley, rye; then flax, potatoes; next the sown grasses, when made into *hay*, in the green state, and tares; leguminous plants, as pease and beans; the *root-bearing* plants in this order—carrots, parsnips, Swedish turnips, yellow turnips, mangold-wurzel, white turnips; clover when cut, as also lucerne, saintfoin, and crimson clover; the sown grasses, when pastured;

and the least exhausting of all, permanent pasture of the natural grasses.

5084. With a choice of such a variety of plants, possessing various powers of exhaustion, there should be no difficulty of arranging a succession of them, as least to deteriorate, and best to suit every kind of soil. There would be no difficulty of fixing a succession in an abstract view of a rotation; but such a rotation cannot be put into practice, as the cultivation of certain plants is dependent on local circumstances. For example, in the neighbourhood of large towns, potatoes, turnips, carrots, are cultivated more with a view to supply the wants of their inhabitants, than the nature of the soil; and stock are not pastured there in summer, because the grass is usually cut for green food, or made into hay and sold. But though circumstances thus operate to modify the rotation in certain localities, the principles upon which all rotations are based may be followed everywhere. The great object in adopting a rotation at all, is to preserve the land from deterioration; and as grains must be raised on every species of arable soil—not only because they constitute the chief food of man, but because they also provide provender and litter to live-stock in winter, both which are requisite for their health and comfort in this cold and damp climate, as also are green crops in winter, when grass cannot be obtained, the only practical mode known of counteracting the deterioration of the soil is to raise, between the exhausting crops, others which require manure in immediate contact with them to raise them to perfection, as is the character of the green crops; and such an alternation of cropping just constitutes a rotation. All crops exhaust the soil less or more, so that it is necessary to pursue an enriching course of manuring, that the crops by the end of the rotation may not be able to exhaust all the manure that has been applied in the course of it. Such a course of cropping, or rotation, is of general application.

5085. It is true that the same sort of grain or green crop can be raised on the same soil, for years in succession, without apparent deterioration of the soil; but it must be done by the instrumentality of manure. The Rev. Mr Jaffray raised

wheat for several years in succession on his glebe, at Dunbar in East Lothian, by applying manure to the soil every year. Theoretically, if the ingredients taken from the soil by any crop are restored to it the soil will not be deteriorated. This theory is being put to the test at the present time, 1850, by Mr John Dickson, Saughton Mains, near Edinburgh, on a five-acre field, in which wheat is to be sown for five successive years; and the effect of the crop upon the soil, each year, is to be ascertained by analysis by Dr Anderson, Chemist to the Highland and Agricultural Society; and such manure is to be applied to the soil every year, containing such ingredients as the analyses shall have shown to have been taken from the soil by the preceding crop.

5086. But although no doubt exists of the ability to raise the same grain in the same soil in successive years, by means of manure, a regular course of cropping is incumbent to be established on all farms which follow the mixed husbandry of crop and stock. A given number of stock, raised every year, requires a given quantity of food every year; and that quantity cannot be secured but by prosecuting a regular course of cropping. It is evident that, if an inordinate extent of any one crop be raised in any one year, it must be done at the sacrifice of as much of another crop, which would have occupied the usurped ground; and if the one crop is as requisite for the support of the stock as the other, the stock will suffer so much for want of it. For example, if more grain than usual, and less green crop, is raised in one season, the ordinary number of stock will either suffer want, by being stinted of the requisite quantity of green food; or part of them must be sold, to suit their numbers to the food raised for them. If they are stinted of food they will become of less value; and if part are sold, the proportion in the breeding of the stock is destroyed, and will require time to recover the number. In reality, the regular system of breeding, and the regular system of husbandry, would both be destroyed by the reckless innovation. The mixed husbandry must therefore be maintained by a regular rotation of cropping. If extraneous food is purchased in lieu of raising a crop, the profit would be ren-

dered dependent on the state of the markets; but the profit from the mixed husbandry is not immediately dependent on the markets, since the farmer breeds, rears, and feeds the same animals, and if *any* profit is obtainable at any period of the animal's life, he receives it. Extraneous food may assist the crop in producing a greater profit, but it may not necessarily produce a profit in lieu of a crop.

5087. Those who purchase stock to suit the quantity of food they raise, may raise crops of every kind without a rotation, the only limit to their plan being the command of manure: but they who follow such a plan are as dependent on the purchase of extraneous manure as on that of stock; and if the manure cannot be obtained, their plan cannot be pursued. Such a plan cannot be generally followed, for if all farmers purchased most of their manures extraneously, where would the manure be found to supply them all? and if all purchased stock to consume the increased crop raised by the extraneous manures, there would be no breeders of stock, except in the pastoral districts, and these could not supply a sufficient number of animals. So that this significant fact ought not to be lost sight of by the farmer, that whenever he depends upon the resources of his own farm, he *must* adopt a regular course of cropping.

5088. In every rotation of cropping, permanent pasture should be left out of consideration, because, being an unchangeable condition of the soil, it cannot be embraced in a rotation, which implies a frequent return of the soil to the plough. A large proportion of permanent pasture has considerable influence in determining the rotation on the arable land, which need not be long under grass; and this is a common practice in England. But it should be borne in mind, that where a considerable proportion of the land is under the plough, a large quantity of manure should be applied to it at one time, and that frequently. So that the practical effect of having one large portion of a farm in permanent grass, and another in arable culture, is to crop the grassy portion easily, and the arable portion severely. Whereas, it would be better for the dura-

bility of the entire soil to undergo a uniform and easy mode of cropping.

5089. *Rotations for strong land.*—Let us now consider the several modes of rotation practised in the different classes of soils found in this country, and under the different systems of husbandry (34) pursued; and I shall first give a few instances of rotation followed on strong soils, and you should keep in mind that we are supposed to be farming 500 acres.

5090. A 2-course rotation is practised on a few strong clays in England, which places half of the arable land under each member of the rotation.

First year, wheat, with manure,	250 acres.
Second year, beans, without manure,	250 ...
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	500
	<hr/>

The grass land is permanent meadow. The manure is given to the wheat; but the land, being naturally fertile, does not require much manure at a time. With so much wheat straw for litter, and hay and bean-haulm for fodder, part of the manure made by the working and other stock is put upon the meadows which yield hay. The land requires to have naturally a good stamina before it can bear so frequent a cropping with wheat.

5091. A 3-course rotation puts one-third of the arable land in fallow, a third under corn, and a third in grass.

First year, fallow,	} 166 $\frac{2}{3}$ ac.	Potatoes, . . .	10 acres.
		Tares, . . .	10 ...
		Turnips, . . .	50 ...
		Beans, . . .	40 ...
		Rag fallow,	56 $\frac{2}{3}$...
Second year, wheat and barley,	} 166 $\frac{2}{3}$...	Winter wheat,	116 $\frac{2}{3}$...
		Spring wheat,	20 ...
		Barley, . . .	30 ...
Third year, grass,	} 166 $\frac{2}{3}$...	Clover, . . .	20 ...
		Hay, . . .	50 ...
		Pasture, . . .	96 $\frac{2}{3}$...
	<hr/>		500
	<hr/>		500

This will answer a poor clay-loam, and on still inferior clay oats should be taken instead of wheat. The beans on the poor land will be best raised on drills, and receive a little manure. The tares should also have manure. The potatoes should have but little on the stubble. The land should be well wrought for the turnips, and be manured for them. The whole rotation, being an easy one for the soil,

may be practised for a few years on worn-out land, until it is brought into good condition, when it might be relinquished for a better.

5092. The following 4-course rotation is very common in England. One-fourth of the arable land is in fallow—that term, in all the rotations, implying the period when the manure is applied—one-half in corn, and one-fourth in grass.

First year, fallow,	} 125 acres,	Potatoes,	. . .	10 acres.
		Tares, . . .	. . .	10 ...
		Turnips, . . .	. . .	50 ...
		Beans, . . .	. . .	30 ...
		Bare fallow,	. . .	25 ...
Second year, wheat and barley,	} 125 ...	Winter wheat,	. . .	75 ...
		Spring wheat,	. . .	20 ...
		Barley, . . .	. . .	30 ...
Third year, grass,	} 125 ...	Hay, . . .	. . .	25 ...
		Clover, . . .	. . .	20 ...
		Pasture, . . .	. . .	80 ...
Fourth year, wheat and oats,	} 125 ...	Wheat, . . .	. . .	95 ...
		Feed oats, . . .	. . .	30 ...
	<hr/>			500
	<hr/>			500

Wheat is a common crop after clover in England, rare in Scotland. The beans are manured in drills. The potatoes are manured, as also the tares. The turnips are well manured. One-fourth of the land requiring manure every year, and half of it under corn, the farm cannot provide the manure required, so some must be purchased.

5093. A 4-course rotation is practised in Scotland in the neighbourhood of towns; where manure is plentiful. It has one-fourth of the land in fallow, one-half under grain, and one-fourth in grass.

First year, fallow,	} 125 acres.	Potatoes,	. . .	30 acres.
		Tares, . . .	. . .	10 ...
		Turnips, . . .	. . .	65 ...
		Beans, . . .	. . .	20 ...
Second year, wheat and barley,	} 125 ...	Winter wheat,	. . .	80 ...
		Spring wheat,	. . .	15 ...
		Barley, . . .	. . .	30 ...
Third year, grass,	} 125 ...	Hay, . . .	. . .	40 ...
		Clover, . . .	. . .	35 ...
		Pasture, . . .	. . .	50 ...
Fourth year, oats,	} 125 ...	Oats, . . .	. . .	125 ...
	<hr/>			500
	<hr/>			500

There need be no bare fallow in the neighbourhood of a large town. Field potatoes being now a precarious crop, early garden varieties are planted on farms; and the ground is more early cleared for wheat in autumn, (4788.) The turnip break is

now, by the help of special manures, greatly enlarged. Hay is always in demand, and cutting clover is now encouraged by means of top-dressings of special manures in spring. All the fallow crops are plentifully manured. This is a profitable rotation on good land in the neighbourhood of a large town.

5094. A 5-course rotation is very general at a distance from towns. It puts one-fifth of the land in fallow; two-fifths under grain; and two-fifths in grass, one and two years old. This is, however, just the 4-course rotation immediately above, with the grass member extended to two years.

First year, fallow,	} 100 acres.	Potatoes, . . .	10	acres.
		Tares, . . .	10	...
Second year, wheat and barley,	} 100	Turnips, . . .	80	...
		Winter wheat, . . .	20	...
Third year, grass,	} 100	Spring wheat, . . .	30	...
		Barley, . . .	50	...
Fourth year, grass,	} 100	Hay, . . .	20	...
		Clover, . . .	15	...
Fifth year, grass, oats,	} 100	Pasture, . . .	65	...
		Pasture, . . .	100	...
	} 500	Potato oats, . . .	60	...
		Common oats, . . .	40	...
			500	

The potatoes, tares, and turnips are all manured, which it is now quite possible to be done by the assistance of bone-dust and guano to the turnip crop. There is no necessity for a bare fallow, the soil being better occupied with a green crop. When the land is somewhat strong, a few beans with manure may be substituted for a like extent of turnips. The hay might be confined to the wants of the farm, and the cutting clover extended in the same proportion, or it might be thrown into the pasture of the first year. Some of the lea on the last year might be rag-fallowed, (4183,) and wheat taken instead of oats. The 5-course rotation is a profitable one at a distance from towns. It might be modified into a 6-course rotation by extending the second years' pasture into the third year. This last course is a good one for the mixed husbandry, as it affords plenty of pasture for the young stock, and the oats yield very abundantly after a three years' lea.

5095. A 6-course rotation, other than the one I have just mentioned, is practised

on good strong land on farms which do not rear young stock. It puts one-sixth of the farm in fallow, four-sixths or two-thirds in grain of all sorts, and one-sixth in grass.

First year, fallow,	} 83½ acres.	Potatoes, . . .	8	acres.
		Tares, . . .	10½	...
Second year, wheat and barley,	} 83½	Turnips, . . .	65	...
		Winter wheat, . . .	18½	...
Third year, grass,	} 83½	Spring wheat, . . .	30	...
		Barley, . . .	35	...
Fourth year, oats,	} 83½	Hay, . . .	12	...
		Clover, . . .	13	...
Fifth year, beans, pease, and swedes,	} 83½	Pasture, . . .	56½	...
		Oats, . . .	83½	...
Sixth year, wheat,	} 83½	Beans, drilled, . . .	43	...
		Pease, broadcast, . . .	10½	...
		Swedes, . . .	30	...
		Wheat, . . .	83½	...
			500	
			500	

The potatoes, tares, and turnips are all manured. No bare fallow is requisite. The hay is confined to what is required on the farm—the cutting clover being more useful in summer, and the pea-straw answers partly for hay in winter. A few swedes in the fifth year, along with the beans and pease a little manured, will be found useful, and keep the land in condition by the manure. The swedes should all be pulled and stored in the autumn, to allow the land to be sown with wheat along with the bean and pea land. This rotation might be made a 7-course one, by extending the grass period to two years; and as the stock would be increased by the extension of pasturage, the turnip break might be proportionally extended in the fifth year, by a corresponding diminution of the beans and pease, or by the suppression altogether of the pease. This is a good and profitable rotation on good strong soil.

5096. Red clover fails in the neighbourhood of towns where the 4-course rotation has been long and constantly followed. The 4-course therefore has been modified into a 6 and 7 course rotation, which have succeeded in restoring the growth of the clover—at least such is the case in the neighbourhood of Dundee. The 4-course has been modified into a 6-course, which puts two-sixths of the farm under green crop, three-sixths under grain, and one-sixth in grass.

First year,	Potatoes, dunged.
Second ...	Wheat, half-dunged.
Third ...	Turnips, dunged.
Fourth ...	Barley, half-dunged.
Fifth ...	Clover.
Sixth ...	Oats, half-dunged.

5097. The 4-course is changed into a 7-course, thus, which gives two-sevenths of the farm to green crop, three-sevenths to grain, and two-sevenths to grass:—

First year,	Potatoes, decayed.
Second ..	Wheat, half-dunged.
Third ...	Turnips, dunged.
Fourth ...	Barley.
Fifth ...	Clover.
Sixth ...	Pasture.
Seventh ...	Oats, half-dunged.

Though the clover still reverts in five and seven years, the frequent manurings keep the land fresh, and clover is well known to thrive on land in a fresh state.

5098. On the fine very strong land of the Carse of Gowrie, a 7-course rotation has been followed for many years. It puts two-sevenths of the farm into fallow; four-sevenths under grain; and one-seventh in grass. It is this:—

First year,	Fallow, dunged and limed.
Second ...	Wheat.
Third ...	Barley.
Fourth ...	Clover.
Fifth ...	Oats.
Sixth ...	Beans and pease, stubble-dunged.

It will be observed, that two white crops follow in barley and wheat; and the reason for this deviation from good farming, is, that fallow wheat is too strong to sow down with clover, while the clover is always good after barley; and that barley always proves a good crop, and exhibits a fine sample, after wheat. Clover does succeed better after barley than wheat; still the rotation cannot be recommended on principle, and in practice it would be better, I think, to change it.

5099. An 8-course rotation puts three-eighths of the farm in fallow, four-eighths in grain, and one-eighth in grass. Thus:—

First year,	} 62½ ac.	Potatoes, .	8 acres.
fallow,		Bare fallow,	54½ ...
Second year,	} 62½ ...	Winter wheat,	62½ ...
wheat,			
Third year,	} 62½ ...	Beans, .	27 ...
beans, tur-		Turnips, .	25 ...
nips, and		Tares, .	10½ ...
tares,			
Fourth year,	} 62½ ...	Winter wheat,	37½ ...
wheat and		Spring wheat,	10 ...
barley,		Barley,	15 ...

Fifth year,	} 62½ ...	Hay, .	20 acres.
grass,		Cutting grass,	17½ ...
Sixth year,	} 62½ ...	Pasture, .	25 ...
oats,		Oats, .	62½ ...
Seventh year,	} 62½ ...	Beans drilled,	22½ ...
beans and		Swedes, .	40 ...
swedes,	} 62½ ...	Winter wheat,	62½ ...
Eighth year,		wheat,	
		500	500

The bare fallow is limed. It and the potatoes are dunged. The turnips in the third year are half dunged. The wheat after beans and tares, and half-dunged turnips, will not be too strong to sow down with clover. The beans in the seventh year are half-dunged in the stubble, and the swedes dunged in the drill. This rotation requires good soil to bear so many corn crops, but its yield of straw is ample. The land should not get sick of clover once in 8 years.

5100. Rotations for light soils. A 4-course rotation (5093) cannot be safely practised on light soils, even with a command of manure, these being rendered almost effete by the too frequent action of the plough. Their best effects are produced by consolidation, under grass. Near towns, the necessity of raising green crops, as the most remunerative ones, subjects every class of soils to the plough; and the change of manure and crops on the same break of land, is the only plan that can be adopted to perpetuate the active powers of the soil.

5101. The 5-course rotation (5094) is therefore most commonly adopted on light soils, and the proportion of its crops are of course the same in light as in strong soils.

First year,	} 100 acres.	Potatoes, .	15 acres.
fallow,		Tares, .	10 ...
Second year,	} 100 ...	Turnips, .	75 ...
wheat and		Winter wheat,	25 ...
barley,	Spring wheat,	25 ...	
Third year,	} 100 ...	Barley, .	50 ...
clover,		Hay, .	10 ...
Fourth year,	} 100 ...	Clover, .	15 ...
grass,		Pasture, .	75 ...
Fifth year,	} 100 ...	Pasture, .	100 ...
oats,		Potato oats,	60 ...
		Common oats	40 ...
		500	500

On light soils this rotation will not supply

sufficient manure to dung the entire fallow break. On gravelly turnip soil, 300 acres in this rotation are unable to manure more than 40 acres out of 60 which was the fallow division, even with a good crop of both turnips and straw. Extraneous manure will therefore require to be purchased for the remaining 20 acres, and fortunately both guano and bone-dust are eminently suitable to such a soil for the raising of good green crops. It is worse than useless to bare-fallow such soil.

5102. But a preferable rotation to this, on light soil, is a 6-course one, obtained by extending the grass division to 3 years, which will reduce the fallow break from 100 acres to $83\frac{1}{3}$ acres, and extend the grass from two-fifths to one-half of the farm. It would be advisable to curtail the potatoes to 10 acres, and extend the proportion of turnips to $67\frac{1}{3}$ acres. I consider this rotation as the best for the pursuit of mixed husbandry, as it seems to balance the relation of the crops and stock. In adopting this modification, from the 5-course shift, it will be advisable to diminish, a little, the number of cattle bred on the farm, and to increase that of the sheep, as of these the ewes are nearly independent of turnips, and the whole flock is almost independent of straw, in winter—which is a consideration, as the number of acres of straw will now be reduced from two-fifths to two-sixths of the farm; but the meliorating rotation may sustain the gross amount of both straw and green crop. A 6-course shift, on light land, gives one-sixth fallow, two-sixths grain, and three-sixths grass. This rotation possesses the advantage of being extended to any length by repeating the grass; but an undue extension in this direction interposes a barrier against every other crop but itself, by reducing the fallow down to nothing, and occupying the entire farm. Even a moderate extension of grass would too much increase the summer provision of the stock, while it diminished as much their winter food.

5103. A remarkable 6-course rotation was followed on the farm of Beauchamp, in Forfarshire, by the late Mr James Scott. The farm consisted of 600 acres, and the rotation divided it thus: two-sixths into

fallow, three-sixths in grain, and one-sixth in grass.

First year,	Potatoes .	100 acres.
Second ...	Wheat .	100 ...
Third ...	Turnips .	100 ...
Fourth ...	Barley .	100 ...
Fifth ...	Clover .	100 ...
Sixth ...	Oats .	100 ...
		600

The potatoes were manufactured into tapioca, (4813) and the refuse given to pigs. Their failure would scarcely now warrant such an extended culture as this; and yet, in 1849, a farmer in Wigtonshire ventured to cultivate 92 acres of potatoes on a farm of 260 acres, and follows no rotation. Cattle are bought in to consume the turnips. This 6-course rotation is a good one for keeping the land clean.

5104. If the clover division were extended to three years' pasture, the expenses would be diminished, and the land probably yield a larger proportional return. Such a modification would convert the 6-course into an 8-course rotation.

5105. Adherence to a good rotation conducts the operations of the farm with regularity and ease; but a slavish adherence to any particular rotation evinces want of judgment. The judgment ought at all times to be exercised according to circumstances, and the character of the season; and modifications thus introduced will most probably benefit both the soil and its occupier. A legitimate mode of deviating from a rotation is this:—The field which grew a crop more exhausting than the rest in the course of one rotation, should bear an ameliorating crop in the following one. For example, where potatoes grew in one rotation, turnips should be substituted in the next; and potatoes, in like manner, may follow turnips. An interchange of soil should take place between the different kinds of turnips, so that swedes being more severe upon the land should alternate with the white turnip. The bare fallow on strong land should alternate with a green crop; and so should barley with wheat. Even a severer course is at times justifiable, such as taking wheat after lea, where there is reason to suspect that oats will fail. A root crop of a different nature, such as mangold-wurzel, or carrot, or even cab-

bage, should alternate for a season with the ordinary roots cultivated. When any crop fails—and clover sometimes does—it should be ploughed up, and another of a different kind taken in its stead. Potatoes often fail; they should be ploughed up, and turnips substituted. Sometimes the swedes are destroyed by insects; then let white turnips be taken as a substitute, or late rape, or bare-fallow the land for autumn wheat. In short, whenever one crop fails, another useful one should be substituted in its place; for if the soil is not occupied with a useful crop, it will be soon taken possession of by a host of weeds. Where a change has been forced upon the rotation, a field may be miscropped to bring it again under the rotation; and of all means of miscropping a green crop is the safest, and with additional manure will recover the tone of the land sooner than any other device.

5106. No practice of husbandry requires, in my opinion, explanation by a satisfactory theory, that its principles may be properly understood, so much as the rotation of crops, but as yet no unexceptionable theory has been propounded. The first was that offered by the late eminent De Candolle, founded on the discovery of Bruggmann's, of the excretory powers of plants, which were corroborated by the experiments of M. Macaire.* De Candolle's theory was, that the roots of plants imbibe soluble matter of every kind from the soil, and necessarily absorb substances not adapted for their support, which are subsequently returned to the soil by the roots as excrements. As plants cannot subsist on matter which they eject, the more of this matter the soil contains, the less it becomes fit to support plants of the same kind. This excrementitious matter from one kind of plant, however, may be taken up by other kinds from the soil, and even rendered again fit for supporting plants of the former kind; and if the latter kinds also expel substances from their roots which may be appropriated as food by the former kind, both kinds of plants will improve the soil in two ways.†

5107. Liebig at first adopted the theory of De Candolle, but afterwards modified his assent in these terms:—"Transformations of existing compounds are constantly taking place during the whole life of a plant, in consequence of which, and as the results of these transformations, there are produced gaseous matters which are excreted by the leaves and blossoms, solid excrements deposited in the bark, and fluid soluble substances which are eliminated by the roots. Such excretions are most abundant im-

mediately before the formation and during the continuance of the blossoms; they diminish after the development of the fruit. Substances containing a large proportion of carbon are excreted by the roots, and absorbed by the soil. Through the expulsion of these matters, unfitted for nutrition, the soil receives again with usury the carbon which it had at first yielded to the young plants as food, in the form of carbonic acid. The soluble matter thus acquired by the soil is still capable of decay and putrefaction; and, by undergoing these processes, furnishes renewed sources of nutrition to another generation of plants, and becomes humus."‡

5108. The power of plants to excrete from their roots has almost been totally denied. Mr Alfred Gyde of Painswick in Gloucestershire, instituted experiments to prove that plants expel no excrements from their roots. His opinion is, that though plants have no power of selection, but take into their texture any solution offered to their roots, they have little or no power of again excreting it; that any excretions are only of the true sap; and that plants watered with excretion receive no injury from it.§ It cannot be denied that plants do excrete substances from their roots. As Liebig affirms above, that they excrete substances from their leaves and blossoms, why should it be deemed incredible that they excrete matter also from their roots? Independently of experiments made upon plants placed under unnatural circumstances, the sense of smell alone is sufficient to prove that plants excrete sensible substances from their roots. Examine the newly turned up ground where potatoes, turnips, carrots, have grown, and the peculiar odour emitted by each of these plants will at once be recognised arising from the soil. The raspberry bush and the mint have a very powerful odour. Indeed, the peculiarity of the odour at once determines the plant which has been growing on the soil. This existence of the odour will not be explained by saying that plants only excrete simple sap, since, sap being alike in all plants, and not distinguishable from water, the odour must proceed from something that has been elaborated by the plant from the sap. There is nothing incredible in the excretory theory; for if the excretions from the roots are vegetable excrements, it may be easily imagined that the excretions, once deposited in the soil, may be as prejudicial to the plant which produced them as would be the excrement of an animal presented to it as food. But the objection to this view is, that it does not explain all the phenomena of rotations, and therefore cannot be received as a satisfactory theory. Its great difficulty is to explain why the excretory matter from one race of plants is not decomposed, and disappear from the soil, long before the recurrence of the same kind of plant in the succeeding years. The excretory matter or matters being organic, they can have no power of conservation, more than other organic sub-

* De Candolle's *Physiologie Vegetale*, vol. i. p. 248-51.

† *Ibid.*, vol. iii. p. 1474-1520.

‡ Liebig's *Chemistry in its application to Agriculture*, p. 33. Edition of 1843.

§ *Transactions of the Highland and Agricultural Society*, October 1843, p. 80.

stances, against the favourable antecedents of fermentation and putrefaction, heat and moisture.

5109. It was then conjectured that different species of plants require a particular nutriment; that wheat, for example, requires a different nutriment from barley or oats, or from any of the green crops; and that, if it were cultivated perseveringly for a number of years, it would entirely exhaust the soil for wheat. Upon this idea the present barren state of the northern coast of Africa, and of the island of Sicily, has been attempted to be explained. It has been conceived that the constant growing of wheat in those countries, to supply the wants of the Roman people, after they relinquished their own agriculture, impoverished the soil to its present condition. Deprived of manure, most soils will become impoverished by cropping; but we have seen (5085) that wheat may be grown in succession on the same soil, if manure is applied. We have no proof that no manure was applied to the raising of the wheat for the Romans in Sicily and Barbary. The progress of botanical physiology soon made it appear that the organs of each plant derive their many juices from substances which concur in the nutrition of plants generally. In effect, plants the most opposite in botanical character and properties, alimentary as well as poisonous, will live and flourish on the same mound of earth, and on the same manure. Such plants reciprocally withdraw nourishment from one another, which could not occur did each species need different elements of nutrition.

5110. As opinions stand in regard to a theory of the rotation of crops, M. Boussingault's opinion appears rational. "That there is no absolute necessity for alternation of crops," he observes, "when dung and labour can be easily procured, is undeniable. Nevertheless there are certain plants which cannot be reproduced upon the same soil advantageously, except at intervals more or less remote. The cause of this exigence on the part of certain plants is still obscure, and the hypothesis propounded for clearing it up far from satisfactory. One of the marked advantages of alternate culture is the periodic cultivation of plants which improve the soil. In this way a sort of compensation is made for exhaustion. The main thing to be secured, in rotation of crops, is such a system as shall enable the husbandman to obtain the greatest amount of vegetable produce with the least manure, and in the shortest possible time. This system can be alone realised by employing, in the course of rotation, those plants which draw largely from the atmosphere. The best plan of rotation in theory, is that in which the quantity of organic matter obtained most exceeds the quantity of organic matter introduced into the soil in the shape of manure. This does not hold in practice. It is less the surplus amount of organic matter over that contained in the manure, than the value of this same matter, which concerns the agriculturist. The excess required, and the form in which it should be produced, must vary widely according to locality, commercial demand, and the habits of people—considerations wholly apart from

theoretical provisions. One point in theory that should agree with practice is this—that in no case is it possible to expect more organic matter, and particularly more azotised organic matter, than the excess of the same matter contained in the manure which is consumed in the course of the rotation. By acting upon another presumption, the productiveness of the soil would be infallibly lessened. Hence, it may be inferred how closely the study of rotations is connected with that of the exhaustion of the soil."

5111. The sentiments of M. Boussingault, regarding the position which the mineral ingredients should take in deciding on a rotation, are sound. "Professor Liebig," he observes, "in insisting with the greatest propriety on the useful part played by alkaline bases and saline matters in vegetation, has shown the necessity of taking inorganic substances into serious consideration in discussing rotations. It is long since I came to the same conclusion myself; but it strikes me that, to be truly profitable, such a discussion must necessarily repose on analysis of the action of plants which have grown in the same soil, and been manured with the same dung, the contents of which in mineral elements were already known. There is in fact a kind of account-current to be established between the inorganic matter of the crop and that of the manure. Although I give every credit to the fidelity of the analysis of vegetable ashes that have been published up to the present time, I have not felt myself at liberty to make use of any of them in the direction which I now indicate. I have not thought that it would be fair or reasonable to contrast such heterogeneous compounds, as the ashes of plants grown at Geneva and Paris, under such dissimilar circumstances, with those produced on a farm of Alsace, where the point is to be explained, though the results of this contrast had reference to a particular species of agricultural phenomena. And then my business was not merely with the scientific question; the manufacturing or commercial element in the consideration also touched me. I had to ascertain how I was likely to stand at some future time, did I presume to act upon the conclusion to which I came. There was nothing for me, therefore, but to analyse the ashes of the several plants which entered as elements into the rotation followed at Bechelbronn, but confining my inquiries to that portion of the plant which is looked upon particularly as the crop—so much of it as remains on the ground and is turned in again, of course, taking nothing from the soil."

5112. To these practical conclusions has M. Boussingault arrived on this subject. "In reviewing the chief points examined," he says, "it will be seen that, as far as regards organic matter, the systems of culture which, in borrowing most from the atmosphere, leave the most abundant residues on the land, are those which constitute the most productive rotations. In respect to inorganic matter, the rotation to be advantageous, to have an enduring success, ought to be so managed that the crop exported should not leave

the dunghill with less than that constant quantity of mineral substances which it ought to contain. A crop which abstracts from the ground a notable proportion of one of its mineral elements, should not be repeatedly introduced in the course of a rotation, which depends on a given dose of manure, unless, by the effect of time, mineral element has been accumulated in the land. A clover crop takes up, for example, 77 lb. of alkali per acre. If the fodder is consumed on the spot, the greater portion of the potash and soda will return to the manure after passing through the cattle, and the land eventually recover nearly the whole of the alkali. It will be quite otherwise if the fodder is taken to market; and it is to these repeated exportations of the produce of artificial meadows that the failure of clover, as observed in soils which have long yielded abundantly, is undoubtedly due. Accordingly a means has been proposed, by M. Schattenmann, of restoring to these lands their reproductive power, by applying alkaline manure. If, under such circumstances, carbonate of soda would act as favourably as carbonate of potash or wood-ashes, the soda salt, in spite of its commercial value (8s. per cwt.,) might prove serviceable, and deserves a trial.*

ON THE FERTILITY OF SOILS.

5113. The fertile state of the soil is a subject intimately connected with that of manures when arable culture is under consideration. Soils may be fertile by nature, or made so artificially, by means of manures. Examples of the natural fertility of the soil have been observed in many parts of the globe. "I have seen," observes M. Boussingault, "in the table-lands of the Andes, wheat fields which had yielded excellent crops annually for more than two centuries. Maize may likewise be continually reproduced upon the same ground without inconvenience. This fact is well known in the south of Europe; and the greater portion of the coast of Peru has produced nothing else, from a date anterior to the discovery of America. Further, potatoes may come again and again upon the same soil: they are incessantly cultivated at Santa Fé and Quito, and nowhere are they of better quality. Indigo and sugar-cane may be brought under the same category. In Europe the Jerusalem artichoke produces constantly in the same place. To this list might be added, according to the recent researches of M. Braconnot, the bog-rose with double

flowers, and *Papaver somniferum*, the opium poppy." Liebig mentions the condition of the country around Naples, which is famed for its fruitful corn-land, that, the farms being situated from eighteen to twenty-four miles distant from one another, and between them there being no roads, and consequently no transportation of manure, nevertheless, corn has been cultivated on them for thousands of years without any manure—that is, without any part of that which is annually removed from the soil being artificially restored to it. He also mentions that there are large districts in Hungary on which, since the memory of man, corn and tobacco have been cultivated in alternate years, without the restoration of the mineral ingredients carried away in the corn and in the straw. In the western parts of the United States of America, wheat to the extent of 50 bushels per acre has been grown on the same soil without manure for 16 years.

5114. What the ingredient, or combination of ingredients, is, which imparts fertility to a soil, is unknown to us; and I suspect that the most elaborate analyses of constituents will afford us no information. Liebig admits that the physical conditions essential to the fertility of a soil are usually neglected in the calculations of the chemist; and a mere chemical analysis is thus of very subordinate value, because the existence of all the mineral means of nourishment in a soil does not necessarily indicate its value. And although the chemical be combined with the mechanical analysis, which estimates the unequal quantities of mixed ingredients—such as coarse and fine sand, and of clay and vegetable matters—and data be thereby furnished upon which to form more accurate conclusions, than by the analysis of one class of ingredients; yet no chemist can tell us, by mere analysis, whether or not a soil is capable of supporting the cultivated crops for an unlimited period, without the use of manures. This may be concluded from what Liebig states of the land in the vicinity of Vesuvius, which may be regarded as the type of a fertile soil. It is derived from the disintegration of lava, and cannot possibly,

* Boussingault's *Rural Economy*, p. 459, 490, and 501—Law's translation.

owing to its origin, contain the smallest trace of vegetable matter; yet every one knows, as he observes, that when lava or volcanic ashes have been exposed for a time to the influence of the air and moisture, all kinds of plants grow in them with the utmost luxuriance.* We thus see, by Liebig's own showing, that we cannot determine the principle which imparts fertility to soils, since the existence of all the mineral means of nourishment in a soil does not necessarily indicate its value; nor does the want of vegetable matters render it less capable of yielding luxuriant crops.

5115. Whatever may be the principle which imparts natural fertility to soils, observation teaches us that climate is an all-important element of fertility—not heat merely, but also the corresponding periodic and adequate supplies of moisture. “Those who can view nature with a comprehensive glance, and apart from local phenomena,” observes Humboldt, “may see, from the poles to the equator, organic life and vigour gradually augment with the augmentation of vivifying heat.” The same idea he thus expresses more beautifully: “The carpet of flowers and of verdure spread over the naked court of our planet is unequally woven; it is thicker where the sun rises high in the now cloudless heavens, and thinner toward the poles, in the less happy climes where returning frosts often destroy the opening buds of spring, or the ripening fruits of autumn;” and more forcibly in these terms, “It is under the burning rays of a tropical sun that vegetation displays its most majestic forms.”† That the constituents of the atmosphere, as such, have no share in this fertility, is evident from the fact of its constant movement causing an equal distribution of the gaseous food necessary for the growth of plants everywhere, so that the tropics do not contain more of it than the cold zones. We of these northern latitudes may therefore feelingly exclaim with Liebig: “Yet how different appears to be the power of production of equal surfaces of land in these regions!”

5116. We have no soils in this country that will bear exhausting crops continually without manure, because our climate is un-

genial; but, fortunately, we have the means of imparting a temporary fertility, which has the effect of producing large crops from most of our soils; and it is generally attained by manuring so liberally as to afford more nourishment to the plants than they appropriate to their use; and the residue is retained in the soil as a store for future use, and as a means of establishing a permanent fertility. The process by which the soil retains the soluble ingredients of manures has been well illustrated by some recent experiments of Professor Way of London. He ascertained that sand and gravel retained only the mechanical admixture of liquid manure, and that the soluble ingredients passed with the water in solution unchanged; but the case with clay was quite different; and there can be no doubt that the property of soils to remove colouring matters, and organic matters yielding odours, from solution, was due to the clay contained in them, and it had the power of retaining the alkalis. If a quantity of ammonia, highly pungent to the smell, was thrown upon a filter of clay soil, the water first coming away would be absolutely free of ammonia. So with the carbonates of potash and soda. This is a valuable property of soils, inasmuch as it renders rain unable to wash out of them those soluble ingredients, forming a necessary condition of vegetation; and even those compounds, when introduced artificially by manure, are laid hold of and fixed in the soil, to the preclusion of any loss either by rain or evaporation. But more than this, such a property of clay does not only affect alkalis and their carbonates, but all salts of those bases, with whatever acid they are combined. Thus sulphate of ammonia, on being filtered through clay soil, left its ammonia behind, and the sulphuric acid obtained was found combined with lime; hence sulphate of lime had been formed in the process, and brought away in the water. Lime was thus destined, in the economy of nature, to be the means by which the salts ministering to vegetation became localised and distributed through the soil, and retained there until they were required for vegetation. There was no provision, however, for the salts of lime themselves, sulphate, muriate, and nitrate of lime,

* Liebig's *Chemistry in its application to Agriculture*, p. 116-18, 3d edition.

† Humboldt's *Aspects of Nature*, vol. ii. p. 8-29.

passing through the soil unchanged; but quicklime, when dissolved in water, is removed by the clay; and carbonate of lime in solution is so effectually removed, that hard water may be softened by the process.

5117. It is not to be supposed that the separation of the salts in solution, could go on indefinitely by filtration. On the contrary, the limit was soon reached; and though small in quantity per cent, the power of retention in reference to the bulk of the soil was great. It was found that pure clay would absorb, perhaps, two-tenths per cent of its weight of ammonia—that is, 1000 grains of soil would separate two grains of ammonia, and well cultivated clay soil would absorb twice as much. If such soil is cultivated to the depth of 10 inches, an acre would be capable of retaining two tons of ammonia, a quantity that would require 12 tons of guano to furnish. Now, one-sixteenth of this power would suffice for the preservation of the ammonia of a large dose of guano, and was therefore a power of great activity. The extent of the power of different soils, and for different of the alkalis, was ascertained; and the power was decidedly a chemical one.

5118. In desiring to ascertain the effect of those principles on ordinary manuring, it is obvious that if there is a provision in the soil for the retention of the salts of manure, and for the ammonia and other products of the decomposition of animal and vegetable matter, the soil is the proper place for those decompositions to go on; and, no matter how remote the period when the crop should be taken, it would be perfectly safe to get the manure into the land as soon as practicable after its production. Again, the equable distribution was a point also which seemed of considerable importance; for, if it was an absolute necessity that a new class of compounds was found in the soil immediately the manure reached it, it would seem to follow that those compounds furnished the elements of nutrition to plants—consequently, we should seek to produce them by every means in our power. Liquid manuring, wherever practicable, is an effectual way of securing this distribution. In the case of special manures, such as chemical salts, much simplicity is introduced by the

new discovery. Henceforth we must regard the different salts, those of ammonia, for instance, as of value in relation to the price of ammonia, or other base contained in them, since they are all alike when incorporated with the soil. This property of soils “explains and confirms,” says Professor Way, “the variations in manuring operations which are made to suit the nature of the soil. Clay has been shown to be the active substance in repairing manure, and sandy and gravelly soils not possessing a sufficiency of clay will be expected to be less retentive of manure. Such is the fact, and soils of this description are said not to ‘hold manure.’ On such soils manures must be applied more frequently and in smaller quantities than in stiffer soils, where, owing to the retentive power of the clay, the manure for several crops may be safely deposited.” Again, “reference has been made to the possibility that clay possesses a power of retarding the putrefactive process. It seems clear that manures in a fresh state are available to vegetation. What otherwise would become of the urine of sheep folded on turnips, and to which the success of the following barley crop is justly attributed? The property of the soil to arrest putrefaction and to combine with organic effluvia, is matter of common observation.”*

5119. Another source of fertility to soils is the quantity of residue left in the soil after the removal of a crop, such as the stubble and roots of the grain, the leaves of the green crops, and the herbage and roots of grasses. Experiments over a rotation of four years were instituted by M. Boussingault, to ascertain the quantity of organic matter left by the residue of the crops taken, and the results were:—

Residue of crops.	Weight due per acre.	Carbon.	Hydrogen.	Oxygen.	Azote.	Salty earth.
Potato tops.	2/32	282	32	189	14	112
Wheat stubble,	12·3	460	50	369	4	67
Clover hay roots, dried in the sun,	1833	615	75	523	26	178
Out stubble,	836	299	32	232	2	30
Sum of organic substances, The manure contained,	6584	1656	189	1313	46	387
		3335	391	2403	186	2995
Excess of organic matter in the manure,		1679	202	1000	140	2608

* *Journal of the Agricultural Society of England*, vol. xi., p. 374-5.

5120. Similar experiments instituted lowering quantities of minerals taken up by a rotation of five crops, gave the following each crop in its respective year:—

	Mineral substances in the crops.	Phosphoric acid.	Sulphuric acid.	Chlorine.	Lime.	Magnesia.	Potash and soda.	Silica.
Potatoes,	lbs. 113	lbs. 13	lbs. 8	lbs. 3	lbs. 2	lbs. 6	lbs. 58	lbs. 6
Turnips, half crop,	50	3	5	1	5	2	19	3
Wheat,	50	24	...	...	1	8	15	...
Wheat straw,	358	11	4	2	30	18	34	242
Clover,	284	18	7	7	70	18	77	15
Oats,	39	6	...	...	1	3	5	20
Oat-straw,	60	1½	2½	3	5	1½	17	24
Sum of mineral substances,	954	76½	26½	16	114	56½	225	310
Mineral substances in the manure,	7582	90	304	32	533	136	339	5049
Excess of mineral matter in manures,	6628	13½	177½	16	419	80½	114.	4739

5121. It appears that the residue of the several crops of a rotation represents the nature, and somewhat less in quantity than one half of the manure originally put into the ground.

5122. It is easy to perceive, from the preceding data, that, what with the organic matters and the ashes, the land is more than supplied with all the mineral substances required by the several crops it produces in the course of a rotation, even of lengthened duration.

5123. The large quantity of organic matter restored to the soil, by several of the crops in the series, explains how the rotation may be closed without its being found indispensable to supply any additional manure in its course. It seems indubitable that, without this addition of elementary matter, the fertility of the soil would decline much more rapidly than it does; the residue of each crop is nothing more than a portion of the crop itself restored to the ground: it is as if we only carried off one portion, the larger portion of the crop, and returned another portion green. We learn that the visible appreciable influence of the residuary matters of preceding crops upon the luxuriance of succeeding ones does not result solely from their mass, even supposing each to be possessed of equal qualities; but they have a favourable influence out of all proportion with its quantity; and this depends especially on an influence exerted on the soil by the crops which leave them.

Had these crops been powerfully exhausting, we should expect that their residue, however considerable in quantity, could do no more than lessen the amount of exhaustion produced; in which case its useful influence, however real, would pass unnoticed, were it estimated by the produce of the succeeding crop. If, on the contrary, a crop has been but slightly scourging, whether in consequence of the smallness of its quantity, or because it may have derived from the air the major part of its constituent elements, the useful influence of the residue will not fail to be conspicuous."

5124. "The excess of mineral matters introduced into the ground over those that arise with the crops—an excess that ought always to be secured by judicious management—enriches the soil in saline and alkaline principles which accumulate in the lapse of years, just as vegetable remains and azotised organic principles accumulate under a good system of rotation."*

5125. The only mode, therefore, in our power to render the soil fertile, after it has first been drained and wrought, is to give it good manure more in abundance of every kind of ingredients than are removed from it by the several crops would amount to; for, unless the manure is in excess, the soil will become sterile under the severe cropping which the cereal grains usually inflict on the arable land. With grass lands in pasture, the effect is different, for constant pasturage increases the fertility

* Boussingault's *Rural Economy*, p. 458, 489, and 501—Law's translation.

of the soil. In this process, the grass plants themselves must have some effect upon the soil, for it is evident that the ground cannot receive so much matter back into it, in the form of dung and urine voided by the animals supported on the grass, as had been taken from it in the form of grass, since the animals fattened on the grass must carry off a considerable proportion of its products.

5126. Whatever functions the humus may perform in the soil in regard to vegetation—and great diversity of opinion exists on the subject amongst chemists—practically, there is no doubt of the fact that, the nearer the soil of the field approaches in character to garden mould, the best of which contains a large proportion of humus, the more fertile it becomes. M. E. Souberain, in his treatise on humus, describes the part which manure plays in the nourishment of plants; and his sentiments are these:—"The woody fibre, which undergoes decomposition in contact with air and moisture, is converted into humus, and at the same time furnishes carbonic acid, which is perhaps absorbed by the roots of plants. The proportion of carbon in humus and manures never exceeds 56 to 57 per cent. This is the extreme limit which the decomposition of woody fibre can attain to in contact with air and moisture.

5127. "Pure humus contains $2\frac{1}{2}$ per cent of nitrogen, which appears to be essential to its composition. Humus is scarcely altered in contact with air. Humus, scarcely soluble of itself in water, acquires solubility by its combination with lime; but the principal agent of its solution is the carbonate of ammonia, which reacts equally on free humus, and on humus combined with calcareous matters. Humus rendered soluble is absorbed by the roots of plants; it serves in a direct manner for the nourishment of the plant. Humus has also a favourable action on vegetation, by attracting and retaining the moisture of the air and ammonia, by facilitating the solution of the earthy phosphates, by ameliorating the physical qualities of the soil, and by moderating and regulating the decomposition of decaying animal matters.

5128. "Manure *par excellence* is that

which at the same time contains the earthy and alkaline salts, ammoniacal salts, animal matter in a state of putrefaction, humus already formed, and vegetable remains in a state of transformation.

5129. "In valuing a manure, it is necessary to take into consideration not only the quantity of nitrogen furnished by analysis, but also the state in which that nitrogen exists in the manure; also the state of the ammoniacal salt, or of the putrescible animal matter, and the state of the soluble ammoniacal salt, or of the ammoniacal magnesian phosphate.

5130. "The analyses of fermented dung which have hitherto been made are defective, in that they have not taken into calculation the loss resulting from the action of carbonate of lime on the salts with an ammoniacal base, during the drying of the manure. The result is, that the tables which have been published, representing the proportion of nitrogen in manures, give only approximate results. The comparative value of manures cannot be estimated by simply reckoning the quantity of nitrogen afforded by analysis; because, on the one hand, the nitrogenous matters are not the only active principles of manures; and on the other hand, because the value of manures depends much on the state of the nitrogen contained in them—and, consequently, it is impossible to frame a table of equivalents for manures."

ON THE DISPOSAL OF THE FAT PIGS.

5131. We left the young pigs at their weaning state in (2861,) and mentioned the probable number that might be disposed of every year from two brood sows, after supplying the farm-house with pork and ham, (2866.) At whatever age the pigs are disposed of, (2865,) and whatever number of brood sows are kept, (2867,) the young pigs when weaned are put into the court *m*, Plate II., and supported until the milk of the sow has dried up, and also sufficient food is ready for them in the grass fields.

5132. Newly weaned pigs ought to receive nourishing diet; and if weaned early in the season, the larger proportion of it

should be warm, until the mild weather arrive, when cold food will suffice, although it should be cooked as long as they are confined in the court. To prevent indigestion arising from excessive action of the acid secretions of the stomach, which young pigs are liable to, salt should always be put into their troughs with the food. The court should be well provided with litter under the shed, and the courtyard cleared of the dung every day. A trough of clean water should be placed in the court for them to drink out of, besides the troughs required for the wash they may receive from the house. Should one litter be weaned before another has left the court, both may be placed together in the court; and, both being fed at the same time in troughs placed at opposite sides of the court, each herd will keep by themselves—provided both get plenty of food, which they ought to receive as long as they remain in the court. For fear, or in case of quarrelling, the younger litter may be placed in one of the brood sties *b'*, Plate II., as it is not likely that both will be occupied at the same time by the brood sows. Failing these, the younger litter may be put into the feeding sties *a'*; and should all these be also occupied, which is improbable, they can be put into an empty hammel *M* or *N*, or even into the out-house *g'*.

5133. Whenever green food becomes abundant on the farm, in the beginning of June, the elder of the young pigs should have a ring put into their noses, (2869,) to prevent them digging in the ground, and turned out during the day in a grass field—giving them some food before they go, and after they return home in the afternoon. On being driven a few times to a grass field, and herded for a few days at first, and not annoyed by dogs, they will willingly go to it in the morning and remain all day grazing, but will desire to return home early in the afternoon, as pigs love to retire early to their litter, even in the longest and hottest days of summer. Notwithstanding their early retirement to bed, pigs are not astir so early in the morning as poultry.

5134. It is the practice in some places to confine the young pigs constantly in courts during all the summer, and supply

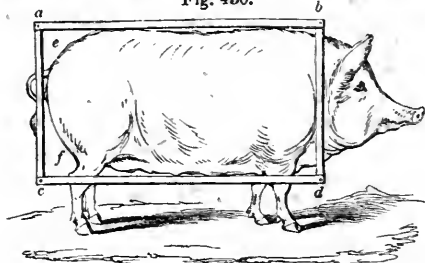
them there regularly with food. They will no doubt thrive under such treatment, but not so well as when they are at freedom to go about at all times in the courts, and to graze in the fields; nor is their flesh so good—it will lack flavour, and the fat be laid on disproportioned to the lean. Such a breed of pigs as is represented in Plate V. will always be ready for slaughter, even when allowed to go about and pick up what food they can, assisted with a little food at morning and in the afternoon. They are always delicate porklings at any age, and may be slaughtered for use at any time without the preparation of feeding.

5135. Farmers usually dispose of their young pigs at home: dealers coming round to purchase them, pay the money and take them away. From 5 to 7 stones are the favourite weights for porkers, and pigs are worth most money at that period in proportion to their weight. Some, however, may prefer to drive them to market to dispose of them; and in that case they must be driven to it, or to the nearest railway station. Whether or not you send pigs to market, you should be made acquainted with the mode of managing them upon the road. It is a common opinion in the country, that pigs will neither lead nor drive—and the opinion is, no doubt, founded on observation; but they may be managed by an appeal to the appetite. If the drover walk before his drove, having a small bag of beans under one arm, and drop a bean now and then upon the road, his eager charge will follow him in search of the desired morsel. An old steady dog following the drove will easily prevent any straggling into fields; but a young one, from his eagerness for work, will annoy the pigs much more than assist the drover. In summer, pigs, when driven, should get leave to drink at any brook or ditch on their way, or pluck grass on the way-side. In the market-field, pigs are retained in their stances by dropping beans now and then around a circle circumscribing the drove, when they will place their heads outwards to pick up the beans, and are easily kept back by a tap on the nose with a switch. I have seen large lots of pigs managed in this way at the great fairs of Newcastle-upon-Tyne. It is said by seamen that the best mode of shipping live pigs is to attempt to

prevent them getting upon the gangway, when they evince a determination to run along it, and in doing so gain the deck.

5136. To judge of pigs, we have only to put many of the rules for judging of oxen into practice. On looking at the pig, fig. 438, we are convinced of the nearness

Fig. 438.



VIEW OF THE SIDE OF A FAT PIG.

which the form of a well-made fat pig approaches that of a fat ox. The rectangular wooden frame *a b c d* placed against the body of a fat pig is nearly filled up in the same manner as is the frame by that of the ox in fig. 296, the only points of difference being in the hind quarter, where the pig usually droops rather suddenly to the tail, as from *e* to the tail, as also the hams fall in more suddenly to the hough, as from the tail to *f*, than in the ox. On looking at the pig both from before and behind, the carcass appears of a rounder form than the ox, the square frame on being applied having spaces at the angles more so than in figs. 297 and 298. On looking down on the back of a pig, as fig. 299 does on that of the ox, it will be observed that the body carries its breadth fully from the shoulders to the haunch. The hand is of little use in judging of a pig, as the skin, being generally thick, and always tight, does not easily yield to the touch; although in a good pig the skin and fat yield on the pressure of the fingers, and regain their position by elasticity immediately on the removal of the hand. The body should be well covered with long hairs lying close to the skin. The shoulder, hooks, back, behind the shoulders, and the flanks, are points which are well filled up in a good pig.

5137. Mr McQueen estimated the number of

* McQueen's *Statistics of the British Empire*, p. 23.

† Bell's *Weekly Messenger*, January 1849 and 1850.

‡ *Parliamentary Return*, February 1849 and 1850.

live pigs in Great Britain in 1836, at 18,270,000, and the value of one-third of them at £2 each, and of the other two-thirds at 10s. each, made the sum of £18,270,000.* Of this number a large proportion belongs to Ireland; and as large herds were no doubt sacrificed there in the year of dearth, 1847, it is questionable that the number has yet been regained, with the uncertainty attending the culture of the potato.

5138. The number of pigs presented for sale at Smithfield in London, in 1848 and 1849, in each month of the year, was as follows:—

	1848.	1849.
January, . . .	2435	1185
February, . . .	1935	1247
March, . . .	2225	1820
April, . . .	2818	1840
May, . . .	2581	2193
June, . . .	2641	2322
July, . . .	2350	2040
August, . . .	2443	2200
September, . . .	3153	2310
October, . . .	3140	2085
November, . . .	2326	2116
December, . . .	1649	2139
	<hr/>	<hr/>
	29,596	23,497
1847, . . .	30,125	

The falling off in the numbers between 1847 and 1849 will be observed to be 6628, no doubt owing to the circumstance I have alluded to above.

5139. The number of foreign live pigs imported into London, duty free, in 1848 and 1849, in each month of the year, was as follows:—

	1848.	1849.
January, . . .	...	1
February, . . .	...	4
March, . . .	...	...
April, . . .	...	19
May, . . .	...	9
June, . . .	...	2
July, . . .	...	104
August, . . .	20	302
September, . . .	55	290
October, . . .	116	243
November, . . .	...	409
December, . . .	8	128
	<hr/>	<hr/>
	199	1511
1847, . . .	448†	

It will be observed that the trade in foreign live pigs into London is very trifling, though an increasing one.

5140. The number of live foreign pigs imported, duty free, into all the ports of the kingdom in 1847, 1848, and 1849, was as follows:—

1847,	1242
1848,	2119
1849,	2653 ‡

Even for the whole kingdom the trade is a trivial one, but it indicates an annual increase.

5141. *Indigestion*.—Should indigestion appear in the young pigs when confined in the court, from the cause indicated in (5132), after salt had been used, the following drench should be given to each pig:—carbonate of magnesia, 1 oz., tincture of rhubarb, 2 drams, tincture of opium, $\frac{1}{2}$ dram, warm water, 12 oz. This is sufficient for 8 doses, which ought to be administered to an empty stomach.

5142. Every one has observed that the tails of young pigs are always curled, but very few know that the curl is always to the right, and very rarely to the left side.

5143. "The skin varies in density in different breeds of swine," observes Mr Youatt. "In some of the large old breeds it is thick, coarse, tough, and almost as impenetrable, in comparison, as the hide of the rhinoceros; while in many of our smaller breeds, and particularly in those which have a considerable admixture of Asiatic blood, and in the Chinese pigs themselves, it is soft, fine, and delicate, and bears no slight resemblance to the skin of the human being. It is not to be wondered at that the structure so delicately organised as the one we have been describing, should be subject to disease. In the hog it is peculiarly so; many of the most serious maladies to which he is subject have their seat in the skin."

5144. *Mange*.—"This cutaneous affection," observes Mr Youatt, "which was formerly attributed to want of cleanliness, or to some peculiar state of the blood, is now generally admitted to arise from the presence of certain minute insects, termed *Acar*i. It is identical with the *scab* in sheep (1071), and the *itch* in the human being." The hog does not appear to suffer much from the mange; the pustules are usually chiefly developed under the arm-pits, and on the interior of the thighs, and from being simply red spots at first, rub into large blotchy sores. Where the mange is recent, a tolerably strong decoction of tobacco or digitalis will often prove an efficacious wash for the diseased parts, or a solution of corrosive sublimate; but if the eruption is of long standing, an ointment of sulphur and mercurial ointment, in the proportion of 1 oz. of sulphur to 1 drachm of mercurial ointment, carefully and thoroughly rubbed into the skin, must be resorted to."

5145. *Measles*.—This is rather a subcutaneous than an actual disease of the skin, consisting in a multitude of small watery pustules, developed between the fat and the skin. Its appearance is of reddish patches somewhat raised above the skin, on the groin, the arm-pits, and the inside of the thighs first, and subsequently on all parts of the body, and is seldom fatal. Flour of brimstone put into apples out of which the cores have been scooped, given to pigs every day to the number of five or six, after having fasted for three days, and continued for five or six days, is very likely to become bene-

ficial, according to Mr Youatt's opinion. He says that measles "sadly injures the quality of the meat, rendering it insipid, flabby, pale, and indisposed to take the salt. We should say that the flesh of measly pigs is positively unwholesome, although perhaps there are no cases on record in which it is proved that bad effects have resulted from the use of it."*

5146. Dr Taylor remarks "that the flesh of animals *over driven*, as well as newly killed meat in general, is liable to produce violent gastric irritation, and even cholera."†

ON THE MANAGEMENT OF FOWLS.

5147. We left all the young broods of the domesticated fowls after they were hatched, from (2880) to (2932,) to be cared for in the progress of their growth in summer. I have still a few observations to make on their management after the hatching season, and on the treatment of eggs.

5148. *Hens*.—The practice is that the hatching of the common fowl shall not extend beyond the end of August or beginning of September, and should not be carried beyond that period, unless more than ordinary care be bestowed on the rearing of the broods. The chickens then hatched will be in excellent condition for Christmas and New Year, and be valuable in a pecuniary point of view, should the farmer choose to avail himself of such a market. But for the farmer's own use, and the presentation of a delicacy at his own table, beyond the power of most to have, the hatching may be continued until the coldest weather of winter arrives. This I have already alluded to in (1617.) The natural hatching of fowls proceeds most successfully in spring and early autumn, there being a cessation in the warm months of June and July. It would be well to attend to this hint from nature, though of course it is quite possible to continue the hatching in the warmest months, by preparing cool retreats for the broods.

5149. Notwithstanding all the care bestowed on fowls, the hen will make her own nest and bring out broods in the corn fields, at the root of hedges and under the cover of shrubs. After being missed for

* Youatt *On the Pig*, p. 98, 102-3.

† Taylor *On Poisons*, p. 555.

a time, the hen will return to the home-stead with a fine healthy brood, all alike in size and colour, to establish her right for subsistence both for herself and numerous progeny; and joyous is the welcome she receives on her return home with her treasure. When such a brood is brought forth, as long as there is plenty of food for them in the fields, the hen will rear them there in preference to bringing them home, and when they do return, the chickens will be strong and well fledged. But when the hatching has been late, and the food is comparatively scarce, the return of the brood will be early, and the demands for attention to their wants the more clamorous.

5150. All fowls that venture to hatch their broods in the fields are liable to be destroyed by vermin, and many an anxious mother-hen, after feeding her brood for some time, has been destroyed with all her young ones, by the ruthless fox. But as far as concerns myself, so high do I value liberty to fowls, on the score of health, and strength of body, and flavour of flesh, that the occasional loss of a hen and her brood would not induce me to deprive fowls of their liberty.

5151. Many cruel experiments are exercised by country people to prevent hens clucking, when they do not wish them to sit on and hatch eggs, such as dipping them in water for a few seconds, pulling feathers from a particular part of their body, and such like barbarities—all alike ineffectual; at least, I never heard of a single instance of their success. The only effectual plan I know, without giving bodily pain to the animal, is to place them in darkness, and there deprive them of food and water for two days and two nights, and, in obstinate cases, for the third day. The simplest means of accomplishing this is to procure a number of light-made tubs, each just large enough to hold one hen within it when standing on her feet, with its top and sides pierced with holes to let in air, but to exclude bright light, which is done by giving the holes such an inclination as to prevent them being directly seen through. Such a tub, placed mouth downward over a single hen, in a quiet out-house, not in the hen-house, for the time specified, will remove the desire to sit. A not uncom-

mon practice is to whelm a large tub over more than one hen, with its mouth raised at one side a little from the ground, which allows as much light to enter the tub as to let the hens see to fight with each other, when their scalps are often bared to the bone, and one of them probably pecked and trampled to death. Some writers recommend the hens to be indulged in their desire for hatching, but as most laying hens have a desire to sit when the ovarium for the time has been emptied of its contents, the number of broods would be increased beyond the powers of the household to superintend with the requisite care, were this desire generally gratified.

5152. A hen will lay eggs when she is tending her brood, and if she has chosen a nest for herself, she will leave the brood when the desire for sitting overtakes her. But if her roost be known, and the eggs regularly removed, the desire for sitting will still come upon her, at the appointed time; and then she must be treated as just directed, to remove the desire.

5153. Autumn is the season for selecting the hens for laying eggs in winter; and they ought to be young, but of different ages, that a succession in the laying may be maintained. Hens readily take to the nests made for them at this season, evincing no desire to betake themselves to the fields.

5154. Autumn is the season of moulting for fowls. The only care they require, in this periodic visitation, is to keep them warm at night. The nights of September become chilly.

5155. *Eggs.*—Hens begin to lay about the beginning of March, and continue to the beginning of October. They do not lay every day, that is, every 24 hours, some laying every other day, and some missing one day in three. They lay about two dozen of eggs at one period, then cease for two or three weeks, and again lay other two dozen, and so on for the number of months mentioned. Of all these months, they lay most constantly in March and April. After each period of laying they are inclined to sit.

5156. One of the daily duties of the

hen-wife, in summer and autumn, is to collect the eggs. Whenever a hen is observed to indicate a desire to lay, a nest should be provided her in a quiet and convenient place; and if directed to it at the commencement of her laying, she will continue to frequent it ever after, if undisturbed. But a nest is not required for every laying hen, as several will lay in succession in the same nest, some hens laying earlier in the day than others; and so tenacious are they of their right to particular nests, that two will not unfrequently occupy the same nest at the same time.

5157. Every place is not equally suitable for a hen's nest. In other places than the hen-house, hens are not fond of laying their eggs on a level with the ground; though a quiet corner in a shed, under shelter, is not unfrequently selected by themselves for the purpose. But they prefer to lay elevated above the ground, such as in the mangers of stables, in a trough of a shed or hammel, in the straw-barn on the top of a mow of straw, in a stack of straw in the stack-yard, on a compost dung-hill, or upon the top of the wall of a stable, byre, or outhouse, under the roof. When nests are made in such places as hens would themselves prefer, they are much more likely to be frequented by them than when a determination is taken to make nests for them. One reason, perhaps, for their preference to the manger of the work-horse stable is, that, in picking up the grains of corn, left there by the horses while the latter are at work in the field, the manger affords the most convenient place when the pressure for laying overtakes them.

5158. The hen-wife should visit every nest, and collect the eggs every day; and the time for collecting the largest number of eggs, and disturbing the poultry the least, is in the afternoon between 2 and 3 o'clock, before the birds begin to retire to roost. A nest-egg should be left in every nest, as it is an established fact, that hens prefer to lay in nests containing eggs to those which are empty—not because hens will sit the earlier or closer for that. Eggs are most conveniently collected in small hand-baskets, and a short light ladder

will afford easy access to nests situated above reach from the ground. Nine eggs weigh about a pound.

5159. Neither dogs nor children should be allowed to run after laying hens, as the chasing and fright make them part with their eggs before they are provided with the shell. Guinea-fowls are incessant chasers of hens. Eggs may be laid by fowls, portions of which are devoid of the shell; and if such be derived from a breed which you desire to preserve, the only way of rendering such an egg prolific is to cover the part wanting the shell with paper and gum, or with a paste of stucco.

5160. The Rev. Mr Dixon has these true remarks on the form of the eggs laid by the same hen. "To every hen," he observes, "belongs an individual peculiarity in the form, colour, and size of the eggs she lays, which never changes during her whole lifetime, so long as she remains in health, and which is as well known to those who are in the habit of taking her produce as the handwriting of their nearest acquaintance. Some hens lay smooth cream-coloured eggs, others rough, chalky, granulated ones. There is the buff, the snow-white, the spherical, the oval, the pear-shaped, and the emphatically egg-shaped egg. A farmer's wife who interests herself in the matter, will tell you with precision, in looking over her stores, 'this egg was laid by such a hen'—a favourite perhaps—'this by such another;' and it would be possible that she could go on so throughout the whole flock of poultry. Of course, the greater the number kept, the greater becomes the difficulty in learning the precise marks of each. From a basket of thirty eggs, gathered in a farmyard as they came to hand, eleven, laid by one or two hens whose race we were desirous to continue, were selected in about two minutes by the friend who supplied us with them. If four dozen eggs, laid by no more than four different hens, were put at random on a table, the chances are that it would be as easy to sort them as the four suits in a pack of cards."*

5161. Whether eggs are used at home or disposed of to the egg-merchant, they

* Dixon *On Ornamental and Domestic Poultry*, p. 152.

should be treated so as to be kept in a fresh state for some time. This end is attained by preventing the air penetrating the pores of the shell, and the yolk coming into contact with the shell. There is just one way of preventing the air entering the pores of the shell, which is of smearing it, while still warm, with butter or melted suet. This is not the general mode of treating eggs in farm-houses, whether intended for use at home or for sale—they being kept in promiscuous heaps, and in the state as taken from the nests. The only means of preventing the adherence of the yolk to the shell, is that of changing the position of the egg every day, from one side or end to the other. If used on the day they are laid, no particular care need be used with eggs. When all trouble is desired to be avoided with eggs, they are sold to the dealers every week, who go about the country with panniers or boxes, and purchase, pack, and take them to the exporters in the nearest seaport town. The price thus received in summer is very low, not exceeding perhaps 4d. per dozen—a price unremunerative for the trouble bestowed on the fowls. At the most abundant season, eggs are never below 7d. per dozen in Edinburgh; and in winter, at Christmas, when the confectioners use large numbers, they are as high as from 14d. to 18d. per dozen.

5162. When eggs are desired to be sent to a distance for the purpose of being hatched, they should not be smeared, and should be packed on end in hard-wood saw-dust—not in fir saw-dust, because of its smell of turpentine—or in bran, in small boxes or casks, such as oyster barrels, which should be as little agitated as possible.

5163. To render eggs a remunerative item of farm economy, they should be preserved fresh, until the scarce season arrives, when they realise a fair price, such as 8d. the dozen. It is easy to preserve eggs in summer, by first smearing them, while still warm, with butter or melted suet, and then packing them on the small end in barrels in salt, oats, or melted suet. Salt will impart a salt taste to eggs, if fresh ones, unsmeared with butter, are packed in it; but certainly not if first smeared with butter or suet. Oats form a good packing, and may be afterwards used

by the fowls. Suet, to be used in this way, ought to be quite fresh, and rendered pure by melting on a slow fire, which has the effect of separating it from any muscular or tendonous matter associated with it. After packing the eggs on end in the vessel destined to contain them—as a barrel or jar—the melted suet, in a warm, not hot state, is poured over them, and which is removed from the vessel, and used for domestic purposes, as the eggs are taken out. Eggs preserved in either of these methods I have found fresh for some months, even so as to contain the milk in them—which is the popular criterion of a fresh egg, but is not so, since an egg may contain it which cannot be fresh or new laid. Lime water is used to preserve eggs, and answers the purpose; but any dry material is more agreeable than a wet one. In truth, any substance that will prevent the air entering the pores of the shell, together with any means that will prevent the yolk adhering to the shell, will preserve them in a sweet state for a considerable time.

5164. *Turkeys.*—Although the turkey hen is a watchful mother, the brood will require daily tending from cold blasts and heavy showers, until they are robust enough to withstand the weather, which may be in five or six weeks. When the disposition to lay overtakes her, the hen slips away from her poults and forms a rude nest under a bank, or among weeds; and although the egg be removed every time she lays it, she will continue to lay in the same nest until the contents of her ovarium are exhausted, (2906,) not heeding whether or not a nest egg is left in her nest. Turkey eggs are justly regarded as a delicacy.

5165. The turkey should not be allowed to sit to bring out a second brood, as the birds will be too late to be of use the same season; and in winter the cold will be apt to dwarf their growth, whatever may be the care bestowed on their protection.

5166. *Geese.*—Goslings are easily injured with hailstones and heavy rains, until they are five or six weeks old, and ought to be looked after and placed in shelter until the storm subsides. A later brood of geese may easily be brought up through

the winter, and will become fine large birds by the Michaelmas of next year. The goose egg is seldom eaten, being strong tasted.

5167. *Ducks*.—Ducks are great layers, dropping an egg almost every day. They commence at the beginning of April, and cease in July. They are very careless layers, leaving their eggs wherever they seek their food; and these, on being discovered by the pigs, are champed up as the most delicate morsels that fall in their way. To secure the eggs of ducks, the birds should be examined before being let out in the morning; and those indicating hard with egg confined in the house till they have laid, and afterwards set at large. They are easily examined by suspending them in the left hand by the wings, and simply applying the points of the fingers of the right hand a little under the tail. Ducks should be hatched neither too early nor too late, as they cannot withstand cold when young. Many people enjoy the flavour of a new-laid duck egg. They are used in cookery as freely as hen eggs.

5168. *Pigeons*.—The dove-cot should be examined as frequently, all summer and autumn, as probability implies that young pigeons are to be obtained. Young pigeons grow so rapidly in warm weather that, unless the time is considerably marked when any particular pair will be ready to be taken, they may have become sufficiently fledged and taken flight.

5169. The pigeons should be regularly fed with the poultry, and, over and above they will go to the fields in search for a variety of food, such as all the species of grains, turnip seeds, and seed wheat, and upon the stubbles in autumn.

5170. "The eggs of all birds," says Dr Thomson, "so far as they have been examined, have a striking resemblance to each other. They consist of four parts,—the *shell*, which is white in the eggs of the common fowl and of many other kinds, but is often coloured or spotted of various colours, so as to give it a beautiful appearance; the *membrana pataminis*, a thin transparent pellicle, immediately within the shell—at the great end of the egg this membrane is detached from the shell, leaving a certain distance between them, which is filled with air; the *white* or *albumen*, a glairy liquid, consisting of albumen dissolved in water,

and contained, like the vitreous humour of the eye, in an extremely thin membrane, divided into cells; the *yolk*, a thick and almost solid yellow matter, enclosed in a peculiar membrane; this membrane, by two ligaments, called *chalarae*, is tied to the membrane of the albumen, and thus the yolk is kept in the centre of the egg."

5171. The constitution of these various parts is as follows, as appears from an analysis of Dr Prout. The *shell* of the common fowl consists of—

Carbonate of lime, with a little of carbonate of magnesia,	97.
Phosphate of lime and magnesia,	1.
Animal matter,	2.
	100.

5172. The *membrana*, according to Hatchett, consists of coagulated albumen.

5173. The *white* or *albumen* coagulates into a firm white solid, when heated to 159° Fahrenheit; and when evaporated to dryness, leaves about 14 per cent of albumen. Dr Bostock has shown that it contains also a little mucus. The constitution of the white, according to him, is—

Water,	80.
Albumen,	15.5
Mucus,	4.5
	100.

Dr Prout obtained, by combustion, the following fixed constituents in 1000 grains of the white of egg, from three different eggs:—

Sulphuric acid,	0.29	0.15	0.18	grains.
Phosphoric acid,	0.45	0.46	0.48	..
Chlorine,	0.94	0.93	0.87	..
Potash, soda, and carbonates of potash and soda,	2.92	2.93	2.72	..
Lime, magnesia, and the carbonates of lime and magnesia,	0.30	0.25	0.32	..
	4.90	4.72	4.57	

M. Mulder has proved that the sulphur and phosphorus are in the state of sulphur and phosphorus, and not in that of acid; and this was to have been expected, from the well-known alkaline reaction of the white of an egg.

5174. Dr Prout's analysis of the *yolk* of an egg which was hard boiled in distilled water, and weighed 316.5 grains, gave these results:—

Water,	170.2	grains, or 53.78	per cent.
Albumen,	55.3	..	17.47
Yellow oil,	91.0	..	28.75
	316.5		100.00

According to Planche, 1000 parts of yolk of egg furnish, at an average, 180 parts of oil. This oil consists of stearin 10, and of elain 90 parts; but the stearin is white and solid, and does not stain paper like oil. He found this stearin and the fat of fowls to agree very nearly. The elain possesses the character of a fixed oil. Chevreul found two colouring matters in the yolk, the one *red* and the other *yellow*. Lecanu, besides the stearin and elain, extracted from the yolk a crystalline matter, which melted at 293° Fahr-

heit, and which he considered as of the same nature with cholesterin from the brain. Dr Prout determined the quantity of fixed constituents in 100 grains of the yolk, by incineration, in three different eggs, thus:—

Sulphuric acid,	0.21	0.06	0.19 grains.
Phosphoric acid,	3.56	3.50	4.00 ..
Chlorine,	0.39	0.28	0.44 ..
Potash, soda, and the carbonates of potash and soda, } .50	0.27	0.51	..
Lime, magnesia, and the carbonates of lime and magnesia, } .68	0.61	0.67	..
	<hr/>	<hr/>	<hr/>
	5.34	4.72	5.81

5175. When we compare the fixed constituents of the white and yolk, we cannot avoid being struck with the difference. The *white* contains a much greater quantity of fixed alkalis than of any other fixed constituent; while in the *yolk* the most abundant constituent is phosphoric acid, which amounts to from 3.5 to 4 grains; or, if we suppose it to exist as phosphorus, it varies in different yolks from 1.55 to 1.77 grains.

5176. The specific gravity of a new-laid egg varies from 1.080 to 1.090; an egg, therefore, is heavier than sea-water, the specific gravity of which is 1.030. When kept, eggs rapidly lose weight, and become specifically lighter than water, this is owing to the diminution of bulk in the contents of the egg; the consequence of which is, that a portion of the inside of the egg comes to be filled with air. Dr Prout kept an egg two years, and found that it lost weight daily, at an average rate of 0.744 grains. The original weight was 907.5 grains, and after two years' exposure to the atmosphere, it weighed only 363.2 grains. The total loss amounted to 544.3 grains, or considerably more than half the original weight. The loss in summer was somewhat greater than in winter, owing, no doubt, to the difference of temperature. When an egg is, therefore, employed as a test of the strength of brine, the newer it is, the stronger is the brine that floats it.

5177. The relative weights of shell and membrane, albumen, and yolk, are very different. Supposing the original weight of the egg to be 1000 grains, Dr Prout found the relative proportions, in 10 different eggs, to be as follows:—Shell and membrane 106.9, albumen 604.2, and yolk 288.9 grains.

5178. When an egg is boiled in water, it loses weight, particularly if it be removed from the water when boiling, and be permitted to cool in the open air. The water will be found to contain a portion of the saline constituents of the egg. The loss of weight from boiling is not constant, varying from 20 to 30 grains, supposing the original weight to have been 1000 grains. The quantity of saline matter obtained by evaporating the distilled water in which an egg was boiled, amounts, at an average, to 0.32 grains.

It is strongly alkaline, and yields traces of all the fixed principles found to exist in the egg; but the carbonate of lime is most abundant, and is obtained by evaporation in the form of white powder.

5179. The source from whence is derived the bones of the chick while in the egg, is still an object of research. At the full term of incubation important changes in the constitution of the egg are completed. "The albumen," as Dr Thomson observes, "has disappeared, or is reduced to a few dry membranes, together with earthy matter. The yolk is considerably reduced in size, and is taken into the abdomen of the chick, while the animal has attained a weight nearly equal to the original weight of the albumen, together with that lost by the yolk, minus the loss of weight sustained by the egg during incubation. The alkaline matters and chlorine have diminished in quantity, while the earthy matters have considerably increased. . . . During the last week of incubation, the yolk has lost most of its phosphorus, which is found in the animal converted into phosphoric acid, and, combined with lime, constituting its bony skeleton. This lime does not exist in the recent egg, but is derived from some unknown source during the process of incubation. Mr Hatchett made the curious remark, that, in the ova of those tribes of animals the embryos of which have bones, there is a portion of oily matter; and in those ova whose embryos consist entirely of soft parts, there is none. In what way the oily matter contributes to the formation of bone it is impossible, in the present state of our knowledge, to conjecture. Nor can any source of the lime of the bones be pointed out, except the shell; and it would be difficult to determine whether the shell loses lime during the process of incubation."*

5180. M. Raspail, in investigating the nature of animal albumen by the microscope, as exemplified in the white of an egg, observes, that "the albumen of the pullet's egg is composed of an insoluble and regularly-organised texture, which contains in its cells a soluble substance much more susceptible of alteration than the texture is. Chemists had previously acknowledged the existence of an albumen soluble in water, and of another which was insoluble; but had not remarked that these two sorts of albumen existed together in the white of eggs, and they had considered this substance as a variety of the insoluble albumen. . . . But the insoluble substance of the white of an egg is rendered apparent only by degrees, and accordingly there is a period when it can scarcely be distinguished in this respect from the soluble substance, and this is when the egg is fresh—that is, recently laid. Hence, as I have already pointed out regarding the vegetable textures, the textures are formed by the aggregation of the particles of the soluble substance, or, in other words, the soluble substance is converted by solidification into the parietes of cells. All these circum-

* Thomson's *Chemistry of Animal Bodies*, p. 446-55.

stances establish a complete analogy between *gluten* in vegetables and *albumen* in animals." *

5181. Of the nature of egg and of seed, the origin of animal and of vegetable individuality, and of the natural analogy between them, M. Raspail thus expresses himself: "The egg and the seed are cells detached from the texture of the mother, in consequence of an influence of an opposite kind. This influence may proceed from an external body which we call the male, or from an internal cause which we altogether neglect to notice. The egg and the seed may more particularly attract our attention, in consequence of their forms and dimensions; but the slice of a polypus, which becomes an entire animal, and the fragment of a potato, which produces a complete plant, are sufficient to teach us that the generative faculty is preserved by the whole organic system, and that the whole organised being is complete in any one of its cells." †

5182. *Putrid eggs*.—"Dr Marchal has reported a case in which four persons were seized with well-marked symptoms of poisoning, after eating for their supper some eggs which were decomposed. One man appeared to be in a state of coma, from which it was difficult to rouse him: his face was livid, his lips blue, his eyes open and fixed, limbs flaccid, and respiration slow. His wife, brother, and one of his sons were affected, although in a less degree, with similar symptoms—complaining of vertigo, weight and pain in the head, pains in the limbs, and disinclination to move. It appears that the eggs which had been eaten in a pudding had a disagreeable and slightly putrid smell, and the whole of these persons were taken ill soon after the meal. The symptoms were not those of irritation, but of narcotism: they all recovered." ‡

5183. Mr M'Queen estimates the value of the poultry, rabbits, &c. in the kingdom in 1836 at from £9,000,000 to £10,000,000. §

5184. The value of the poultry, dead or alive, imported into this country in 1849 was L.31,795, and the duty paid on them was L.1771. The duty from British possessions is L.2, 12s. 6d. per cent *ad valorem*, and L.5, 5s. from foreign countries. ||

5185. The importation of foreign eggs into the kingdom was as follows, in number—

1847, . . .	77,485,487
1848, . . .	88,097,277
1849, . . .	97,903,151

5186. The duty payable on the import of foreign eggs is 10½d. on 120 in number, and on those from the British possessions 2½d. ¶

5187. In (2957) I mentioned a method of converting cock chickens into capons by a simple

operation. Since then I have seen a small practical treatise on the art which deserves attention, inasmuch as by the use of proper instruments, and appropriate appliances for securing the animal while under the operation, the operator may go through the process of caponing by himself with certainty, and with comparatively little pain to the animal. The chicken is placed with its left side downwards, and secured in that position by a strap confining the wings, and a lever holding down the legs a little asunder. An incision is then made in the side of the chicken with a peculiar form of knife; and held open by a pair of blunt hooks to allow the testes to be seen. These are then removed from their seat, one after the other, by means of a scoop, which divides the membrane that covers them, and it is provided with a noose of horse hair, whose action, operating as a saw, cuts asunder the ligatures which bind them to the back-bone. The operation is represented so certain that fifty chickens may be caponed without killing more than one or two.

5188. Chickens intended for capons may be operated upon at any age, though between two and three months old is considered the most favourable time. Old fowls seldom survive the operation. At five or six months old they are less liable to have the testes burst in the operation than younger ones, but they are more apt to bleed to death than those from two to four months old. They very seldom die after the operation, unless they have received some internal injury, or the flesh of the thigh has been cut through. The wives and daughters of the poultry farmers in Sussex, Essex, and Herts constantly practice the art of caponing.

5189. Previous to the performance of the operation, the chickens must be kept entirely without food and even water for about thirty-two hours, as that time has been ascertained by experiment to be the best to secure the greatest chance of success, by causing the bowels to be empty, and lessening the tendency to bleeding.

5190. The effect upon a chicken being converted into a capon is, in about a twelvemonth, nearly to treble or quadruple the size of the bird. It has been ascertained that a pair of capons of the Dorking breed once reached the enormous weight of 25 lbs., a weight far superior to the majority of turkeys. The capon generally brings double or treble the price of common poultry.

5191. The writer remarks that, "in regard to the feeding of capons, we wish we could say much in favour of the metropolitan, or even of many of the provincial feeders. The fine large fowls which are seen in the poulterer's shops have undergone the process of castration, and then they are placed in some dark place, enclosed in coops, and crammed with barley or other meal, formed into a paste by means of hot liquor; and

* Raspail's *Organic Chemistry*, p. 243-4. † *Ibid.*, p. 75-6. ‡ Taylor *On Poisons*, p. 562
 § M'Queen's *Statistics of the British Empire*, p. 25.
 || *Parliamentary Returns*, 15th March 1850. ¶ *Ibid.*, February 1849 and 1850.

this mode of feeding is repeated several times in a day. The consequence of this overloaded crop is, that the bird becomes indisposed to move, and is half put to sleep, and is soon quickly covered with unwholesome fat. The capon feeders are very much belied if they do not go farther than this: they mix ardent spirits with the paste with which the birds are crammed, and that and the darkened place in which they are confined dispose them to be stupid and half asleep, and they become literally bloated with fat. The process, however, cannot be long continued, for fever must of necessity ensue, or apoplexy will carry off the bird, or the whole of the carcass will be reddened and spoiled by the redundancy of blood."

5192. In regard to determining the sex of eggs noticed in (2883), this writer says, "As in breeding with a special view of making capons, male chickens alone are required, those should be selected to set under hens which produce males—namely, such as have the *sharpest points*. The men who were formerly employed in the rearing of game fowls were so expert in their selection of the male eggs, that we knew one instance of a breeder employed by a Mr Storer of Nottingham, who out of 13 eggs would select 11 from which he undertook to produce male birds."

5193. "It is rather singular," farther remarks this writer, "that the emasculation of the young gander has never been tried in this country, for there is no reason why as perfect a capon (if one may be allowed the expression) should not be made of a gander as of a cock. It is a practice followed in some parts of Germany and Russia, and in the latter country particularly in the town and vicinity of Larko-Lelo, we once saw a flock of goose capons, the lightest of which must have weighed 15 lbs. at six months old. The Russians, however, entertain a strong prejudice against making capons even of fowls, on a religious principle; but this is, like the majority of prejudices, founded in ignorance and superstition."* The same may be said of caponing the male turkey, (2958.)

5194. Mr Cantelo's hydro-incubator was exhibited in Edinburgh in 1850, and I observe that it has been improved in construction since I mentioned its operations in (2948.) The tray in which the eggs are hatched is now covered with a plate of glass instead of water-proof cloth, and immersed in water at the temperature of 108° Fahr., and beside being a safer receptacle, it affords the opportunity of noticing the process of incubation from first to last.

ON THE ANIMALS DESTRUCTIVE TO POULTRY.

5195. *The Fox*.—The common fox, *Vulpes vulgaris*, is the most formidable destroyer of poultry. If undisturbed, he will

return to their haunts and carry off one after another, until a large number be abducted. The season in which he is most active in his predatory excursions is in the summer, when he has his young cubs to support; and he does not confine his roamings to the shades of night, but will almost boldly frequent the steadings in the afternoons when the animals are at pasture, and the people at work. Just before the poultry go to roost, he frequently pays a visit to the steading, and snatches up a goose or a turkey, and runs off with it to his earth. The abduction is so quietly done, that the fowl may not be missed until next morning, unless it happen to be a particular bird, such as the principal cock, oldest gander, turkey-cock, or peacock. Contrary to his practice with lambs, he does not carry off the young of poultry if he can conveniently lay hold of the older bird. The loss must be put up with; for, whatever precaution the farmer may use in spring for the protection of his new-dropped lambs (2545,) he would acquire an unenviable character amongst sportsmen were he to lie in wait with a gun for a fox. But such watching would at any rate be useless, for the fox is too cunning to return to the same place for some time to try his chance at another capture; and he takes care to keep off a rival from a distance; so that the missing bird is almost certain to have been stolen by a fox from the nearest covert. Foxes scent hens and turkeys to their nests in the fields, and carry them off. On losing favourite birds, such as a turkey-cock, Chinese gander, and young peacock, I have discovered their remains, chiefly the feathers, in the coverts in the neighbourhood, where the foxes had formed their earth for many years. Like the dog which buries his bone, the fox buries his plunder in the earth to preserve it fresh.

5196. *The Polecat*.—Polecats or fourmarts, *Mustela putorius*, visit steadings under night, and if a hole in the door, or a slit in the wall, by which poultry enter, be left open, they will creep in and commit great havoc among the grown-up fowls, sucking the blood and leaving the carcasses. It is only by the negligence of the henwife that they can find access into

* *Practical Instructions in the Art of making Capons*, 16-28.

the hen-house. Polecats may be caught by placing a steel-trap immediately behind the inside of the hole of the door of a hen-house, in such a way as that the intruder cannot escape the trap, which need not be baited, but only covered with a little chaff, and will spring whenever the animal places its fore-feet upon it.

5197. *The Weasel*.—Weasels, *Mustela vulgaris*, frequent steadings, and do both harm and good. They do good in destroying rats and mice, by sucking their blood. I once observed a weasel and brown rat meet under a shed, and, from the attitudes they both assumed, I anticipated a fight. The weasel, however, was evidently to be the aggressor; and on approaching near the rat, the latter squealed so in utter fear that he apparently could not run away. On making a spring, the weasel seized the rat by the throat; and although the struggle between them was violent, the rat was soon silenced in death. When a weasel takes up its abode in a corn-stack, not a mouse dares remain in it; and if a pole is placed from such a stack to the window of the granary, the weasel will find its way into the latter, and effectually deter any rat or mouse from entering or remaining in it.

5198. But unfortunately weasels do harm as well as good, in killing young poultry, by sucking their blood—a chicken, a duckling, or a gosling, being in an unsafe place, if basking in the sun at the bottom of a dry stone-wall facing the south. They steal eggs too. One day I observed a weasel crossing a road at some distance from the steading, rolling an egg before it with its fore-paws. On allowing it to proceed, I traced it to a lot of felled trees at the road-side, amongst which it had accumulated a store of 17 hen eggs; and it must have done so in a short time, as the eggs were all quite fresh.

5199. *The Rat*.—Rats, however, are the most troublesome vermin, because they harbour in the steading. They not only make every place they frequent dirty, but disgustingly so. The mischief they do in cutting holes in boarded floors, in undermining stone pavements, gnawing harness, consuming and wasting every edible thing, and killing hens and pigeons when sitting

on their eggs, is very considerable. The old black rat of the country, *Mus rattus*, is now nearly extirpated; and the fiercer, dirtier, more mischievous, and dangerous brown rat, *Mus decumanus*, has taken its place.

5200. Of the many plans devised for the destruction of the rat, I suspect that the box-trap is the most ineffectual. A new trap may capture a few rats at first, but it soon becomes recognised, and scrupulously shunned, however luring the bait it contains may be.

5201. Steel-traps are much more effectual, and when used with skill occasionally, not constantly, will destroy large numbers of rats in a short time. Of all the feats of rat killing I ever witnessed, none equalled that of a Yorkshireman, of the name of John Featherstone, by means of steel-traps. He had 21 small traps, which he always kept clean and bright. On commencing his operations, he traced the tracks of the rats along the floors to the tops of the walls, leading commonly by the corners of the apartments to the partition walls, which they surmounted below the slates. After he had discovered their different runs, he made a number of small firm bundles of straw, which he placed against the bottom of a wall in the apartments in which runs had been traced upon the floor, and also upon the tops of the walls where runs were observed under the roof. He used 7 traps at one place at a time, and a greater number of bundles of straw were used than merely to conceal the number of traps at each place, employing his entire number in three places, at a little distance from each other, and in different apartments. The traps were set in a row, behind the bundles of straw, and not allowed to spring at first, and baited with oatmeal, scented with oil of rhodium, with a little chaff strewed over them. They were thus baited for two days, the baits being renewed as soon as it was discovered, by inspection, that they had been consumed. On these days, people were prevented as much as possible from frequenting the apartments in which the traps were placed, and dogs were entirely excluded. Removing the check from the springs on the third day, and arming himself with a short stout stick, having a game-bag slung across his shoulders,

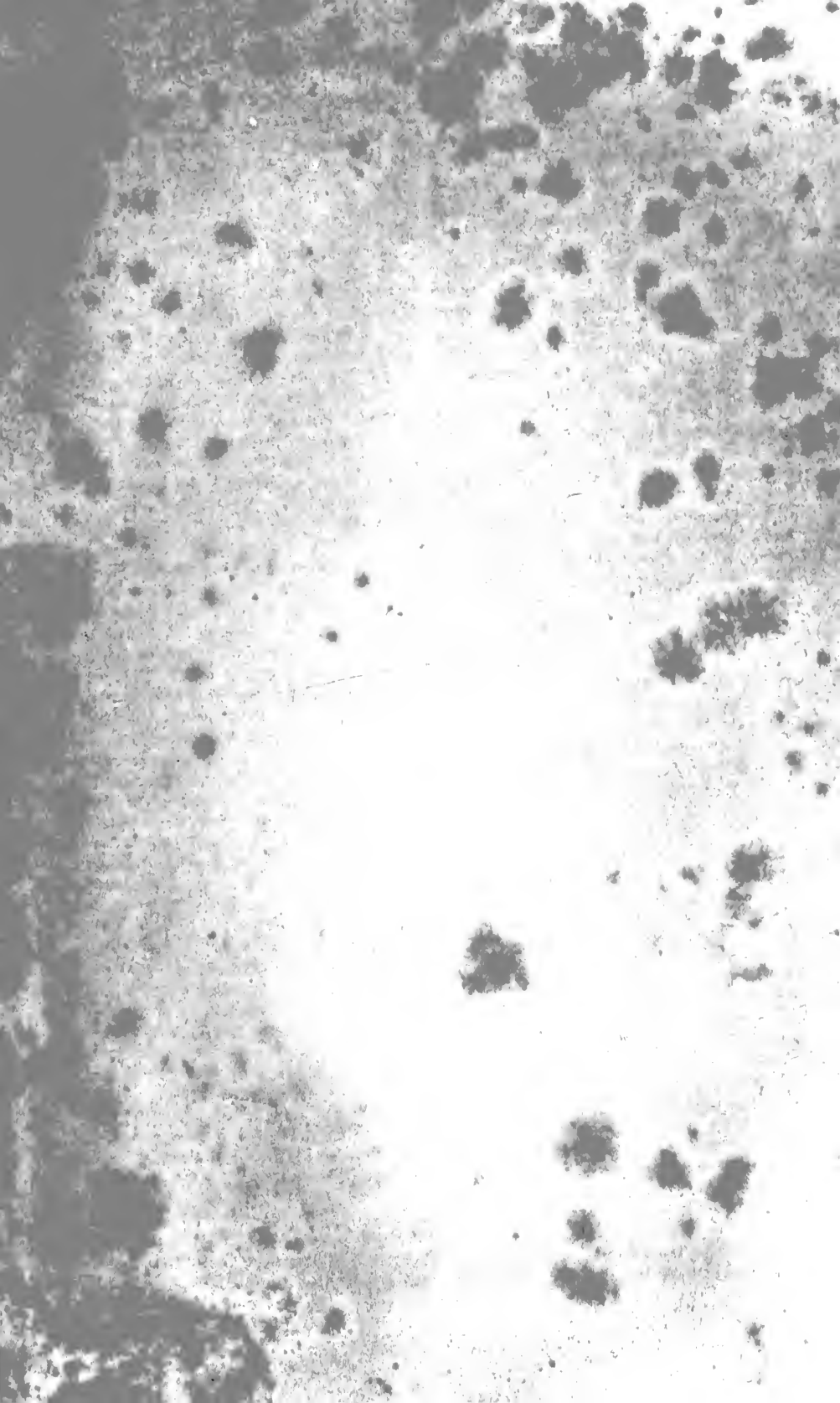
Featherstone was on the alert; and the moment he heard the click of a trap he ran to it, removed the bundle of straw, knocked the rat on the head if alive, threw it out of the trap, set it again, replaced the bundle, bagged the rat—all in a few seconds—and then resumed the watch. In the course of the day, from morning to afternoon, he had collected 385 rats; and, allowing every trap to have done equal execution, each had caught more than 18 rats. He bargained for 1d. a rat, and his food; and in three days he earned in money, £1, 12s. 1d. All the rats were of course not cleared off by this capture; but they received such a thinning, as to prove comparatively harmless for years. Featherstone's first business, on the day following the capture, was to clean each trap bright, before setting out on his journey; and he seemed to place greater reliance on the cleanly state of his traps than on any other circumstance—and thereby, no doubt, the suspicion of the rats was allayed.

5202. Besides such mechanical means, others have been devised for the destruction of rats. It is said that coal-tar smeared around the mouth of their holes will drive them away. Poison is a favourite instrument for the destruction of this vermin. Rabbit flesh chopped up with arsenic, or carbonate of barytes, is recommended by one party; and a salt herring so used is recommended as strongly by another. The following is a recipe for making rat phosphorous poison, which, it is said, has proved efficacious: Take of lard or dripping $1\frac{1}{4}$ lb., of phosphorus 1 drachm, spirit of wine 1 gill. Put the whole into a clean pint bottle. Melt them gradually, by immersing the bottle in a bath of hot water. When dissolved, cork the bottle, and incorporate the ingredients by shaking. When cool, pour off the spirit of wine. Take flour and rub white grated sugar in it, and make a paste with the contents of the bottle, melted. Divide the lump of paste into two portions. Flavour one with a small quantity of the oil of rhodium; the other with oil of anise. Make balls of both portions of the dough, of the size of marbles each. Place them in the way at night where rats most frequent.

5203. As a means of the prevention of rats lodging and breeding upon the tops

of partition walls in steadings, I have recommended them to be beam-filled (1687;) and under the floors of apartments I have also recommended a mode of constructing floors (1681,) and of laying pavements (1687.)

5204. Together with building up the tops of partition walls, I believe there is no way of scaring rats and mice from a steading so effectually as by *cats*. Let one or two cats be brought up in different parts of a steading, according to its size, and if situate at a distance from dwelling-houses, they will become vigilant guards against these vermin; and if the steading is very near, the house-cats will perhaps frequent it sufficiently often for the purpose. When kept in the steading, let each cat receive daily, at its own particular place, and at a stated hour, say 11 o'clock A.M., a mess of new milk and porridge, when it will attend to receive it as the hour arrives; and let each have a soft, warm, comfortable bed made for it in some quiet spot of the steading. At night, and early in the morning, they will watch and hunt on their respective beats; and in the course of a short time, provided access be freely afforded to every apartment of the steading, the vermin will be seldom and more seldom seen, until they disappear altogether. Cats are quite common about steadings and stables; but they are generally neglected of food, on the erroneous idea that, if fed, they become lazy and will not hunt. So far from this being the case, a regularly fed cat makes the best hunter, because it then hunts for sport; and not feeling pressed by hunger, it will watch at the same spot for hours. Being in stout condition, from its daily wholesome food, it feels itself strong enough to encounter any vermin, and will destroy numbers in the course of a day. A starved cat, on the other hand, which hunts for food, eats the first prey it catches, and, gorging itself lies down to rest, in accordance with the habits of the feline race to which it naturally belongs; and neglect a cat of food—let it depend for subsistence entirely on its own powers—and hunger in the long run will prevent its watching altogether. The great use of the cat is to scare away, not devour vermin; and, when obliged to leave the steading in search of food, it will most likely



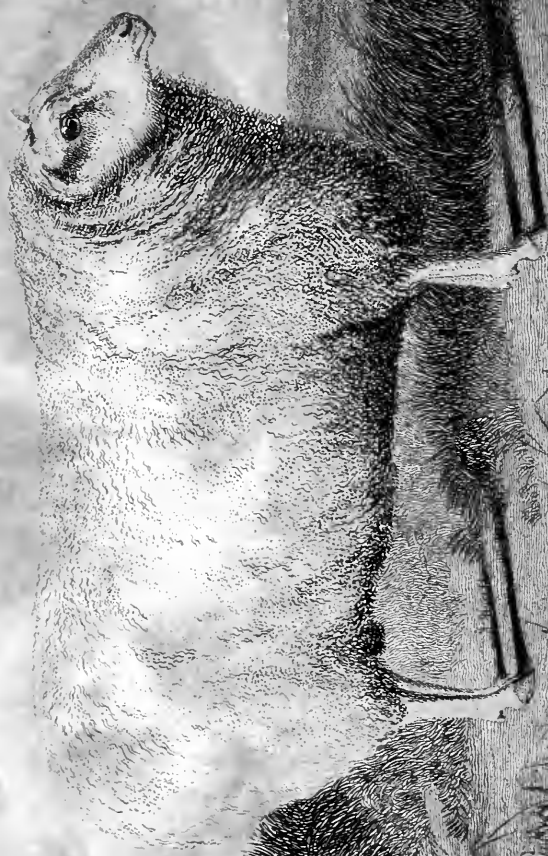


PLATE III.
THE BEAVER.
J. H. SCHREIBER FUR.

Wm. H. Woodcut, N.Y.

go to the hen-house for an egg, to the hatching-house for a young chicken, or to the dove-cot for a young pigeon. It will even hunt the fields for game. I have caused my greyhounds to run down and worry many a cat in the fields. The truth is, most people will not take the trouble to feed a cat daily and regularly in the steading; and the consequence is, that none will *remain* in it, to destroy and scare away vermin, when food can be obtained more easily elsewhere.

5205. The Greeks used to tie bunches of rue under the wings of their fowls, to prevent cats worrying them, as cats, it seems, have a strong aversion to that herb.

5206. *Rooks*.—Rooks, *Corvus frugilegus*, watch for stray eggs that may have been laid among the litter in the courtyards, or near the watering pond, and carry them off in their bills.

5207. The carrion crow, *Corvus corone*, also carry off eggs and young poultry; but its art in effecting the destruction of poultry is simple compared with the cunning and vigilance of the magpie.

5208. *The Magpie*.—The habits of the magpie, *Pica melanoleuca*, are thus described by Professor Macgillivray:—"The food of the magpie consists of testaceous mollusca, slugs, larvæ, worms, young birds, eggs, small quadrupeds, carrion, sometimes grain, and fruits of different kinds, in search of which it frequents the fields, hedges, thickets, and orchards, occasionally visits the farmyard, prowls among the stacks, perches on the house-top, whence it sallies at times, and examines the dunghill and places around. Although it searches for larvæ and worms in the ploughed fields, it never ventures, like the rook and several species of gulls, to follow the plough as it turns over each successive furrow. It has been accused of picking the eyes of lambs and sickly sheep, I think

with injustice; but it sometimes carries off a chicken or duckling, and sucks an egg that may have been dropped abroad." The Professor relates several marauding anecdotes of the magpie from various authorities, and one is from the work of the late Bishop of Norwich: "The female was observed to be the most active and thievish, and withal very ungrateful; for although the children about the house had often frightened cats and hawks from the spot, yet she one day seized a chicken, and carried it to the top of the house to eat it, where the hen immediately followed, and, having rescued the chicken, brought it safely down in her beak; and it was remarked that the poor little bird, though it made a great noise while the magpie was carrying it up, was quite quiet, and seemed to feel no pain while its mother was carrying it down."* Two striking anecdotes are related by Mr Weir of Boghead: "Mr Wark, farmer at Hardhill," he observes, "told me that his brother, upon his property of Old Hall, in the parish of Dunlop, shot off the leg of a magpie as she was carrying off a chicken from his house. She was not seen during the winter and spring, but appeared again in summer. Lame though she was, she still carried on her murderous operation. One day he perceived her in pursuit of a duckling; it immediately ran to the water for protection. So intent, however, was she upon its destruction, that she ventured too far in after it, and got herself so wet that, before she was able to rise in the air, he knocked her down with a stick. A few years ago a boy told me, that while he was tending his cattle, he heard several loud screams in a young plantation in the neighbourhood. Being anxious to ascertain the cause of the noise, he immediately ran to the place whence it proceeded, and, to his astonishment, he beheld a magpie standing upon the back of a hare almost half-grown, picking out its eye, the other having been torn out before his arrival."†

* Stanley's *Familiar History of Birds*, vol. i. p. 251.

† Macgillivray's *British Birds*, vol. i. p. 566-72.

REALISATION.

ON THE DIFFERENCES IN THE PHYSICAL GEOGRAPHY OF FARMS.

5209. On the supposition that the pupil in practical husbandry has acquired a competent knowledge of farming to conduct a farm on his own account, by having familiarised himself with the entire routine of operations throughout the four seasons upon a farm, under an intelligent farmer, and by having consulted the instructions contained in the preceding pages, as a safe guide in leading him to anticipate and understand the several operations as they had occurred, the time has arrived, in pursuance of the object I had in preparing this work of its being useful to the young farmer, for me to point out to him the particulars to which he should specially direct his attention in looking out for a farm for himself—in judging of the land in bargaining for the lease—and in providing the stocking for his farm. Beyond these, it may be necessary for him to enclose and drain the farm, and to erect farm-buildings upon it; and in case he adopt any kind of farming which undertakes the breeding and rearing of livestock, he should be made acquainted with the correct principles upon which the breeding and rearing of all the domesticated animals may be pursued with success.

5210. The farms of this country occupy every available space of ground, from the tops of the highest mountains, to the lowest level of the plains. On a diversity of ground implied in such a wide range, it is not to be expected that the same system of farming can be prosecuted. On the contrary, in consequence of such a diversity, the different kinds of farming I described from (36) to (51,) and the operations adapted to each, which I have treated in detail in their respective seasons, have long been pursued with equal skill and success.

5211. The causes which have operated so to diversify the systems of farming in this country are perhaps these:—Sheep can occupy the whole range of pasture from the mountain tops to the plains. Cattle are confined in their pasture from the secondary mountain tops to the plains. Hence, the highest mountain range is occupied solely by sheep, and there, in consequence, *pastoral* farms which breed sheep only are found; and these are the hardy, mountain, heath-sheep, commonly called the Black-faced breed. From the high elevation of sheep pastoral farms, they are necessarily subjected to much wind and rain, occasioning both wet and cold; and were it not that the tops of mountains face different directions—one part affording shelter and comparative warmth, while the opposite may be experiencing the fiercest onsets of the elements—such farms would be unfit to be inhabited by even the most hardy breed of sheep.

5212. On looking at such a farm with the view of taking it, the ground should in the first instance possess diversified aspects, and not one long stretch of inclination either to the S. or N.; because, in winter, even the south face of a hill will often be covered deep with snow, while the north is almost clear, where the sheep will subsist on the young shoots of the heather. Steep slopes are also of use in winter, as the snow cannot lie deep upon them. The geological structure of the surface should be attended to. Where debris covers the rock the subsoil will be porous, and the pasturage green with little heather; and where no debris occurs, the rock will be covered with peat-earth and heather, encouraged by the presence of water constantly descending upon the face of the rock. Such water proves useful in giving origin to springs of pure water, which are grateful to the sheep in the drought of summer. The rocks on such farms are generally of the

primary formation, and where granite or clay slate prevails, debris may be looked for; but neither gneiss nor mica slate is usually covered with debris, and only with peat-earth.

5213. Since sheep can occupy the whole range of farm grounds, and cattle only from the secondary hills to the plains, it follows that both sheep and cattle may be reared on the second description of pastoral farms, (36.) The farms occupying a lower range of hills than the preceding, have their surface diversified with large round-backed hills, suited to afford good shelter to every kind of stock. And as hills cannot exist without corresponding valleys, valleys possessing considerable breadth, and abundance of haugh land along the banks of a river, are well suited to the rearing of cattle, either by themselves or in company with sheep; but in narrow and steep valleys, sheep alone should be preferred. The sheep best suited for such pasturage are the Cheviot and the Southdown breeds, and the cattle are the North and West Highland breeds, (35.) Instead of rearing both cattle and sheep on such farms, commonly either the one or the other is preferred, the cattle being reared on those having most low grounds, and sheep having most high grounds. Even where extensive haughs are found, sheep are often reared in preference to cattle; and few store-masters desire to be troubled with both cattle and sheep breeding, where accommodation for stock of every kind in steadings is limited, and variety of winter food not abundant.

5214. On reviewing such a farm, it should possess as much green pasture as possible, which it is enabled to grow by the subjacent rocks being of slaty structure, such as greywacke slate, and slate clay, through the fissures of which the water passes as through a porous subsoil. The less debris that covers those rocks the drier will be the pasture, for water passes more easily through their slaty structure than their debris, which consists of a large proportion of clay. Where debris exists, extensive portions of flat surface may be expected to be occupied by swamps and bogs, which grow heather—but which, however, may be easily dried by drainage, the fall for drains being

ample, and drain pipe-tiles affording an easy means of filling them.

5215. Were arable culture extended further than it is on such farms—upon the best haugh ground, for example, and on the slopes adjacent thereto—and a commodious steading set down, both cattle and sheep might be raised with advantage as well for the tenant as the land, inasmuch as, where pasture is judiciously managed in summer, by a proper admixture and distribution of stock, it raises a proportionally large quantity of food for both cattle and sheep, than for either alone. Sheep follow and bite the pasturage closer than cattle, and the grass springs up afresh after the sheep. But, to derive the greatest advantage from such an arrangement, the land should be drained, and the pastures enclosed, to allow of the confinement of the stock in one place until the grass grow in another. Such an arable pastoral farm should have as much S. exposure as possible, which will be determined by the circumstance whether it is on the N. or S. of a high mountain range. The direction of the valleys in which the steading should be situated is a point worth considering,—for as our greatest winds are from the S.W., and the greatest colds from the N.E., every valley running S.W. to N.E. will be much more exposed, both in winter and summer, than in any other direction. A plantation thrown across such a valley both above and below the arable land would screen it, the steading, and the farm-house effectually; and the shelter besides of a higher hill to windward, or to the N., ought not to be overlooked in choosing such a farm.

5216. On the slope of the ground from the foot of the secondary mountains into the plains, will be found the sites of all the systems of farming in practice, with the exception of the two kinds of pastoral farming which we have just been considering. The soil on such a slope rests on trap alone, red sandstone alone, mountain limestone alone, or on red sandstone and limestone, containing projecting eminences of trap. Such a situation is eminently adapted for growing turnips; and accordingly we find prevailing there the mixed, (49,) the dairy, (45.) and that system of farming practised at a distance from towns,

in which no breeding of stock is attempted (48.) Generally on such slopes, though diversified by undulations, the soil on all the different kinds of rock requires draining; and where it does not, the dry soil consists of travelled gravel and sand, constituting the debris of rocks brought from a distance.

5217. On the plain, towns and villages are found on the margins of rivers which are making their way to the sea or to an estuary. The soil is either thin clay or gravelly—both travelled materials—but resting upon diluvial clay, impervious to water. Draining is absolutely requisite to render the soil fertile; and the farming there is generally different from that on the preceding locality, occasioned by the demands from the towns and villages—the inhabitants of which derive all their vegetable food from the adjoining farms and gardens, (42.)

5218. Where the plain extends to the bank of a large river or estuary, the soil changes to a uniform mass of alluvial strong clay, unfit for any of the preceding modes of culture, and is cultivated in a manner peculiar to itself, called carse farming, (39.) Such soil requires draining; but, even after being drained, it is unfit to be worked, or even meddled with, in winter, in rain, snow, or frost, on account of its unctuous aluminous character. It will grow turnips after being drained, but will not receive sheep upon it in winter; and hence no sheep are bred on such land. It cannot be pastured in summer, in a wet season, in case the surface be poached with the beasts' feet; and hence no cattle are bred upon it. It is chiefly devoted to the raising of grain, straw, and hay, which it does abundantly, and is well adapted for the soiling of cattle in hammels, in summer, upon the clover which it grows in luxuriance.

5219. Such are the various physical causes which have given rise to the different modes of farming practised in this country. No change can be introduced into the pastoral farming of either sheep or cattle, except the extension of arable culture, for the purpose of raising a sufficiency of winter food. Were this done, the stock would not only be maintained

in the best state of health on the farm all the year round, but when disposed of, being in fine condition, would fetch larger prices; while in the low country, they would be quicker fed both on pasture in summer, and on turnips in winter. The carse farming cannot be materially altered; and the farming in the neighbourhood of towns must preserve its peculiar character, as long as the demand for straw, hay, grass, potatoes, and turnips, continues. While milk and butter and cheese are wanted, the dairy farming must be pursued. The only change, then, that can be effected in the general farming of the country, is the extension of the mixed husbandry which includes the breeding of cattle and sheep, to the extinction of that species of farming which avoids breeding and subsists on the purchasing of cattle and sheep from pastoral farms. It may be deemed impracticable for farmers to become breeders of stock in the low country, as long as pastoral farmers breed stock, and dispose of them before they are fit to be slaughtered. I am not of that opinion; because, although a farmer breeds stock on his own farm, he need not necessarily be prevented purchasing stock to fatten in winter on turnips raised on all his fallow-break; or in summer, on pasture or soiling grass. Besides, where breeding cannot with propriety be adopted, as on carse farms and those in the neighbourhood of towns, cattle have to be purchased to be fed on turnips on carse farms; and both cattle and sheep may be profitably fattened, in the neighbourhood of towns, on the turnips and grass which have not been sold to the townspeople. Thus a large demand would always be found in the low country for the surplus stock of the pastoral farms, curtailed as these would necessarily be by an extension of arable culture.

5220. In addition to these views of the physical geography of a farm, when it is examined, other circumstances affect its value, such as of the following character:—The land may have such a steep inclination as to require increased strength to work it. The soil may be too strong or too loose. It may be in too wet or too dry a state. Its natural condition may be poor. The fields may want water in summer, though there may be abundance of it in winter or spring. The water may be only supplied

from the surface, instead of from springs. The fences may be either injudiciously formed, or in a state of dilapidation. The position of the farm, in respect to exposure, to the N. or S; the form of the surface of the fields, whether each slopes in more than one direction; whether the farm is exposed in an open country all round, or sheltered on one or all sides by natural or artificial objects; whether coal and lime are far off, or near at hand; whether the market town is distant or near, and whether it possesses the means of supplying a considerable quantity of manure; whether the roads are well planned, and kept in good repair, or a railroad is to be found within a reasonable distance;—what effect all these circumstances of a physical character, individually and collectively, have upon the money value of the land, it may not be easy to determine; but that they have such an effect is most obvious to the understanding.

ON CLIMATE AND ITS EFFECTS.

5221. The state of the climate is too little attended to by farmers when they are on the outlook for a farm; and yet their daily experience teaches them that climate has a marked effect upon vegetation.

5222. The distribution of heat over the surface of the globe constitutes *climate*; and as every place is affected by the distribution of heat, every place possesses a climate in common with every other place in similar latitudes. This constitutes the *general* climate of the place; but every place also possesses a *local* climate, occasioned by the particular configuration of the locality which affects the distribution of heat, and which may render the local climate better or worse than the general one.

5223. General climate is measured from the equator to the polar circles in spaces, in each of which the longest day is half-an-hour longer than that nearer the equator; and from the polar circles to the poles, it is measured by the increase of a month. The breadths thus assumed for these spaces are quite arbitrary, as is most of the zones into which the surface of the globe is subdivided, and these zones are classified into

torrid, temperate, and frigid — names exclusively indicative of different degrees of temperature.

5224. The *torrid* zone contains the space inscribed by the ecliptic, and comprehends $23^{\circ} 28'$ on each side of the equator, or one belt of $46^{\circ} 56'$ in breadth. It is the hottest portion of the globe, the sun being over the zenith, and the mean temperature ranging from 84.2° to 78.8° Fahrenheit.

5225. The *temperate* zones lie one on each side of the tropical, embracing a range of latitude in each hemisphere of $48^{\circ} 4'$, and extending to latitude $66^{\circ} 32'$. Its mean temperature varies from 78.8° to 39.9° .

5226. The *frigid* zones each comprehends as many degrees from the poles as the tropical zone extends from the equator — namely, $23^{\circ} 28'$. Their mean temperature varies from 39.9° to 31° .

5227. Within 10° of the poles the temperature differs little; and the same is the case within 10° of the equator. The mean temperature of different years varies very little near the equator, but more and more so as the latitudes approach the poles.

5228. Thus the temperature of the air diminishes gradually from the equator to the poles. This diminution is found to take place in an arithmetical progression, which is, *that the annual temperature of all the latitudes are arithmetical means between the mean annual temperature of the equator and the poles.* This law was first discovered by M. Meyer; and by means of an equation founded on it and afterwards rendered more simple, Mr Kirwan calculated the mean annual temperature of every degree of latitude between the equator and the poles, and of every month of the year.

5229. It appears, from these calculations, that, of the annual mean temperature of the months, January is the coldest month in all latitudes above 48° ; and that, in latitudes below that, August is the warmest month. In the northern hemisphere, the temperature rises from about the middle of January, slowly at first, more rapidly in April and May, to reach its maximum

point in July and August, when it begins to fall again until mid January, when it is at its minimum.

5230. The difference in temperature between the hottest and coldest months increases in proportion to the distance from the equator. At the equator the mean temperature is 84.2° ; at the ecliptic it is 78.8° ; at Paris, in latitude $48^{\circ} 50'$ it is 51.4° ; at London, in latitude $51^{\circ} 31'$, it is 50.7° ; at Dublin, in latitude $53^{\circ} 23'$, it is 49.1° ; and at Edinburgh, in latitude $55^{\circ} 57'$, it is 47.4° .

5231. The hottest temperature which has yet been registered for the open air was that observed by Buckhardt in Upper Egypt at 117° , and the lowest by Captain Back in North America at 68.8° below zero, the difference between the two cases being 185.8° .

5232. Modifications of temperature occur in accordance with a difference of configuration of the earth's surface. Were that surface uniform, the power of the soil to absorb and radiate heat would be everywhere alike, and the climate of a place would depend on its geographical position: the isothermal lines would all be parallel with the equator. But the diversity in the surface causes the soil to be dry in one place, and swampy in another; to be here a moving sandy desert, and there an umbrageous forest, all which cause corresponding varieties in climate, in proportion as the surface becomes heated in different degrees in one or other of those conditions.

5233. In penetrating great continents from the sea-coast, the temperature both in summer and winter becomes extreme, the mean between them being great; and there are places which with different latitudes have nearly the same mean annual temperature.

5234. An island, a peninsula, and the sea-coast experience a more temperate and equable climate—the summers less sultry, the winters more mild—than a continent. On the Continent, at Königsberg in Prussia, in latitude 55° , the cold in winter is 18°

below zero; while in the Faroe Islands, in latitude 62° , the ponds and lakes never freeze in winter, the winter temperature being only 40° .

5235. One of the grand characteristics of a maritime climate is the small difference between the mean temperatures of summer and winter. At Edinburgh that difference only amounts to 19° , while at Moscow, on nearly the same parallel of latitude, it is 50° ; and at Kasan, in latitude 56° , it is as much as 56.3° .

5236. "The climates of different parts of the earth's surface are unquestionably owing in great measure to their position with respect to the sun. At the equator, where the sun is always nearly vertical, any given part of the surface receives a much greater quantity of light and heat than an equal portion near the poles; and it is also still more affected by the sun's vertical rays, because their passage through the atmosphere is shorter than that of the oblique rays. As far as the sun's mean altitude is concerned, it appears from Simpson's calculations, that the heat received at the equator in the whole year is nearly $2\frac{1}{2}$ times as great as at the poles; this proportion being nearly the same as that of the meridian heat of a vertical sun, to the heat derived at $23\frac{1}{2}^{\circ}$ from the poles, in the middle of the long annual day at the poles. But the difference is rendered still greater by the effect of the atmosphere, which intercepts a greater proportion of the heat at the poles than elsewhere. Bouguer has calculated, upon the supposition of the similarity of the effects of light and heat, that in lat. 45° , 80 parts of 100 are transmitted at noon in July, and 55 only in December. It is obvious that, at any individual place, the climate in summer must approach in some degree to the equatorial climate, the sun's altitude being greater, and in winter to the climate of the polar regions."*

5237. But, how interesting soever it may be to know the annual mean temperatures of places, they are not sufficient to make us acquainted with their climate, as it affects the products of the farm. These mean temperatures are derived from

* Polehampton's *Gallery of Nature and Art*, vol. iv. p. 42.

observations made on thermometers placed in the shade. But as our crops are not placed in the shade, and are exposed in the day to the full force of the sun's light and heat, and at night to a much reduced and it may be a chill temperature, what we desiderate, before we can determine the agricultural climate of any place, is a series of observations from thermometers placed exposed in the open air to all the influences of the weather day and night, summer and winter, from which we may deduce, not mean temperatures, but actual temperatures occurring in any month of the year during the day and the night. A comparison of mean temperatures will, no doubt, let us know which of two places enjoys the greater heat on the average of days or months; but it does not tell us the greatest and lowest degrees of heat felt at the place in the course of any season; and it is this knowledge that most interests us in the cultivation of our crops. We know that a given number of days, at a certain temperature, are necessary to bring a certain crop to perfection, and that another certain temperature will destroy that crop; but the mean temperature alone will not tell us whether or not that crop will thrive in any given place.

5238. Thus, at Venezuela, according to M. Codazzi, wheat requires 92 days to ripen at Turmero, at a mean temperature of 75.6° , which is equivalent to 6955° ; and a hundred days at Truxillo, the mean temperature being 72.1° , which is equivalent to 7210 . Now, in Scotland neither of these amounts of temperature would suffice to bring wheat to perfection; for, suppose wheat to be sown in autumn, and that active vegetation commences at the 14th of February, it cannot be expected to be reaped before the 15th of August—that is, in 182 days; and as the mean temperature of Edinburgh we have seen to be 47.4° , (5230.) the number of degrees of heat required to ripen it would be 8625° , being 1670° more than are required at Turmero, and 1415 more than at Truxillo. But if we take the case of spring wheat, the difference will be still greater; for, suppose it is sown on the 14th of February, when vegetation begins to quicken, it cannot be expected to be reaped before the 1st of September, which is 198 days, and at 47.4° of mean temperature

it gives 9385° , being no less than 2430° more than is required at Turmero, and 2175° than at Truxillo.

5239. Boussingault informs us, that in Alsace, with a mean temperature of 59° , wheat requires 137 days, or 8083° to ripen; at Paris, with a mean temperature of 56° , 160 days, or 8960° ; at New York, with a mean temperature of 63° ; 122 days, or 7680° .

5240. In Egypt, on the banks of the Nile, with a mean temperature of 70° , barley requires 90 days, or 6300° , to ripen; at Santa Fé de Bogota, with a mean temperature of 58.5° , 122 days, or 7137° .

5241. In South America, maize comes to maturity in 92 days, with a mean temperature of 81.5° , or 7497° ; or in 183 days, with a mean temperature of 59° , or $10,797^{\circ}$.

5242. At Maracaibo, near the lake of Valencia, potatoes require 120 days, with a mean temperature of 78° , or 9360° to ripen; and at Antisana, they require 276 days to be in the ground, with a mean temperature of 52° , or $14,352^{\circ}$.

5243. From these and similar data, M. Boussingault comes to the conclusion that “the duration of vegetation appears to be in the inverse ratio of the mean temperature; so that if we multiply the number of days during which a given plant grows in different climates, by the mean temperature of each, we obtain numbers that are nearly equal. The result is not only remarkable, in so far as it seems to indicate that upon every parallel of latitude, at all elevations above the level of the sea, the same plant receives in the course of its existence an equal quantity of heat; but it may find its direct application by enabling us to foresee the possibility of acclimating a vegetable in a country, the mean temperature of the several months of which is known.” In coming to this conclusion, we perceive that M. Boussingault does not take the mean temperature of the year of any place, but that of the seasons in which the particular crop cultivated grows, and which, in truth, comprehends all the temperature of the growing period of the crop.

5244. Another conclusion arrived at by M. Boussingault is, "that plants in general, those of tropical countries very obviously so, spring up, live, and flourish in temperatures that are nearly the same. In Europe and in North America, an annual plant is subjected to climateric influences of the greatest diversity. The cereals, for example, germinate at from 43° to 47° or 48°; they get through the winter alive, making no progress; but in the spring they shoot up, and the ear attains maturity at a season when the temperature, which has risen gradually, is somewhat steady at from 74° to 78°. In equatorial countries things pass differently: the germination, growth, and ripening of grain take place under degrees of heat which are nearly invariable. At Santa Fé, the thermometer indicates 79° at seed as at harvest time. In Europe the potato is planted with the thermometer at from 50° to 54°, and it does not ripen until it has had the heats of July and August.

5245. "Germination, and the evolution of those organs by which vegetables perform their functions in the soil and in the air, take place at temperatures that vary between 32° and 112°; but the most important epoch of their life—ripening—generally happens within much smaller limits, and which indicate the climate best adapted to their cultivation, if not always to their growth. . . . In high latitudes, the disappearance of vigorous vegetation in plants may depend quite as much on intensity of winter colds as on insufficiency of summer heat. The equable climate of the equatorial regions is therefore much better adapted than that of Europe to determine the extreme limits of temperature between which the vegetable species of different kinds will attain to maturity."* Following up this idea in regard to the plants of the farm, the extremes of the temperatures of the following plants may be stated as under:—

Wheat from	78° to 44°
Barley, ...	80° ... 59°
Potatoes, ...	78° ... 52°
Flax, ...	74° ... 54°

has a close connection with that of the air immediately above it, and is mainly affected by the extent of the thermometrical variations in the superincumbent air in the course of the year. In the higher latitudes, where the variations of the temperature of the air is great, the variable depth of temperature in the ground is considerable. M. Arago found that a thermometer buried at 26¼ feet under the surface at Paris did not remain absolutely stationary. Below a limited distance, however, under the surface, the temperature ceases to be affected by variations in the temperature of the general atmosphere, and the point where the affection ceases is called the point of *invariable temperature*. In climes of great constancy, the point of invariable temperature will be found near the surface, and about the equator the point is about the surface.

5247. Drainage raises the temperature under the surface—that is, it permits the temperature of the atmosphere to penetrate deeper into the soil. In one quoted case, in a garden in Hampshire, the temperature of the heavy soil was said to have been raised 15° by drains of 4½ feet deep.† But drainage not only permits the heat to penetrate deeper into the soil, it enables the soil to retain it a longer time. In March 1850, the temperature was very low—for 7 nights out of the first 18, the thermometer sunk to 26°—and yet the following table shows a greater degree of warmth, at 1 and 2 feet in depth under the surface, than for several years preceding in the same month, by 1.17° at 1 foot, and 1.44° at 2 feet:—

	1 foot deep.	2 feet deep.
Mean of March, 1838.....	41°.48	41°.46
" " 1839.....	41.46	41.93
" " 1840.....	39.24	41.71
" " 1844.....	41.55	42.14
" " 1845.....	37.79	38.37
" " 1846.....	44.47	45.55
" " 1847.....	40.22	41.03
Mean of these preceding } years.....	41.16	41.74
Mean of the first 18 days } in March 1850.....	42.33	43.18

5246. The temperature of the ground

5248. One great cause of the reduction

* Boussingault's *Rural Economy*, p. 647-59—Law's translation.

† *Gardeners' Chronicle*, 20th October, 1849.

of the temperature of the surface of the ground is the *evaporation* of the water in it. Rain falls and penetrates the ground by its gravity, and as it is gradually absorbed, a succeeding rain descends still lower, until an equilibrium as regards moisture is established from top to bottom of the ground. Whilst this is going on interiorly, the air which rests on the surface of the ground, and which is imperfectly saturated, tends also to take from the upper layer a portion of its humidity, and evaporation takes place. The upper layer, dried in consequence, draws moisture from that which is more moist beneath; and this moisture, in its turn, is also taken up by the atmosphere. "Having observed for several days," observes Mr R. Thompson of the Chiswick Gardens, "the relative amount of evaporation from a surface of water, and that from earth completely saturated, in the month of August 1849, and under a temperature of 73° to 75°, the following were the results:—

	Evaporation from the Water.	Evaporation from the Earth.
1st day, . . .	.590 inch.	.161 inch.
2d . . . . .	.531 . . . . .	.097
3d . . . . .	.452 . . . . .	.070
4th . . . . .	.472 . . . . .	.051
5th . . . . .	.460 . . . . .	.051
6th . . . . .	.433 . . . . .	.047
7th . . . . .	.370 . . . . .	.051
	3.308	0.528

We see from the above with what rapidity evaporation goes on when the soil is completely saturated. On the first day it is more than one-fourth of the evaporation from the surface of water; but it diminishes, and at the end of seven days it is scarcely one-seventh. When the surface becomes dry, the evaporation is almost inappreciable. On the second day the upper layer of soil is dried, under the above temperature, to the depth of one-tenth of an inch; and at the end of eight days, plants of which the roots extend only to the depth of four inches begin to suffer, and require watering. From some observations made by Hales, on the amount of evaporation from soil, he concluded that it was in the proportion of 3 to 10, as compared with that from a surface of water.*

5249. Another disturbing cause of the equable temperature on the surface of the earth, is the inequality of surface into hill and dale. As we ascend a mountain the heat rapidly decreases, and it decreases more rapidly during the day than during the night, during summer than during winter, where the mountain is abrupt than where it rises in steps, and near the surface than at a distance from it. If we take 590½ feet as an average height, under the circumstances mentioned above, to be ascended to obtain a decrease of 1° of temperature, we shall not be far from the truth.† This height corresponds nearly with a depression of the barometric column of .7 of an inch, (86.) The cold which prevails among lofty mountains is ascribed to the dilatation which the air from the lower regions experiences in its upward ascent—to a more rapid evaporation under diminished pressure, and to the intensity of nocturnal radiation.

5250. As the temperature of the atmosphere constantly diminishes on ascending above the level of the sea, the temperature of congelation must be attained at a certain height above every latitude; consequently, mountains which rear their heads above that limit must be covered with perpetual snow. The elevation of the frozen region varies according to the latitude of the place, being at all times highest at the equator and lowest at the poles. In the higher regions of the atmosphere, especially within the tropics, the temperature varies but little throughout the whole year; and hence, in those brilliant climates, the line of perpetual congelation is strongly and distinctly marked. But in countries remote from the equator, the boundary of frost descends after the heat of summer, as the influence of winter prevails, thus varying its position over a belt of some considerable depth.

5251. Beyond the line of congelation is another, which forms the boundary of the ascent of visible vapour, and this point it is obvious must be less liable to change than the point of congelation. At the equator the highest point of vapour is 28,000 feet, at the pole 3432 feet, and in

* *Gardeners' Chronicle*, December 1849.

† *Kaemtzt's Complete Course of Meteorology*, p. 211-16.

N. lat. 54° it is 6647 feet. In tracing this point successively along every latitude, we learn that heat diminishes, as we ascend, in an arithmetical progression. Hence it follows, that the heat of the air above the surface of the earth is not owing to the ascent of hot strata of air from the surface, but to the conducting-power of the air itself.*

5252. Plains present only one species of climate, which differs in its seasonal characters alone; but mountains exhibit every variety, from their latitude to the pole along the meridian of the quadrant. For this reason, high mountains, situate in the tropics, present every variety of climate. "If we take each mountain," says Mr Mudie, "which rises above the line of perpetual snow, as the index to its own meridian, we shall find that each one expresses, by its vegetation, all the varieties of climate between it and the pole; and thus those lofty mountains become means of far more extensive information than places which are situated near the main level of the sea, and more especially than plains, which, when their surfaces are nearly flat, have no story to tell, but the same uniform and monotonous one, for many miles." "Upon each particular rock of the rapid slope of the Cordillera," observes M. Humboldt, "in the series of climates superimposed in stages, we find inscribed the laws of the decrease of caloric, and of the geographical distribution of vegetable forms."

5253. Elevation above the surface has the same effect in diminishing temperature as ascent in latitude. "Say that the altitude of the mountain under the equator," observes Mr Mudie, "upon which the seasonal action is displayed, is a little more than three miles. Then, estimating in round numbers, one foot of altitude on the mountain will correspond to about 16,000 feet on the meridian—that is, a single foot of elevation on the mountain is equivalent, in difference of temperature, to about three miles, or more nearly three minutes of a degree in latitude, and therefore 20 feet are equal to a whole degree; and when one once arrives at the mean temperature of London, 400 feet more of

elevation will bring one to the climate of Lapland."

5254. The meteorological habitudes of plants being extremely various, one germinating at 38°, a little above the freezing point, and another requiring a heat of 100° or 120°, the geographical distribution of plants is a consequence of the distribution of heat over the surface—that is, of climate. Applying this principle to the temperature of the British Isles, M. A. Petermann delivered a discourse on the isothermal lines of Britain; and the distribution of its plants, to the British Association for the Advancement of Science, in 1849, of which the following is an abridged form of the introductory part:—The climate of Western Europe is comparatively milder than all other countries of a similar latitude. The isothermals of 70° and 30° Fahr. were in North America from 30° to 57° N. lat.; in Asia, from 30° to 50° N. lat.; but in Europe, from 30° to 71° N. lat. The British Islands are placed almost in the centre of the latter zone. The isothermals for January give a general direction from N. to S., instead of from W. to E., as might have been inferred. Between the Shetland Islands and the southern coast of England, except Cornwall and Devon, there is no difference in the winter temperature; but between the E. coast of England and the W. coast of Ireland the difference amounts to about 10°, the former being at an average of 35°, the latter probably 45°. The coldest portion of Britain extends from the Naze to the Firth of Forth, comprising to the west all the Pennine chain: in this district an average temperature of 35° to 36° prevails. The average direction of the isothermals of the hottest month (July) is from S.W. to N.E. The highest summer temperature in the British Isles—indicated by the isothermal of 64°—occurs in the central portion of the S. coast of England, the lowest in the N.W. part of Scotland, and the difference appears to be at least 10°; while the difference between the W. and E. coasts is much less. The isothermal of 62° extends to Lincoln, Birmingham, and the southernmost portions of Wales. All Ireland, Wales, the northern part of England and Scotland, to

* *Encyclopedia Britannica*—art. *Climate*, 7th edition.

+ Mudie's *World*, p. 132-6.

the foot of the Highlands, lie between the isothermals of 62° and 60° . North of the Highlands the temperature is very considerably lower; Inverness having only $55^{\circ} 7'$. The author then alluded to the influence of temperature on the distribution of plants, the districts of which he had found to be strikingly corroborative of the general correctness of his isothermals.

5255. Notwithstanding the marked interest commonly attached to the subject of general climate which we have been illustrating, the characteristics of the *local* climate engages the attention of the farmer much more than those of the general climate of the country which he inhabits. Local climate may be defined to signify that peculiar condition of the atmosphere, in regard to heat, moisture, and wind, which prevails in any given place. The diversified character which it displays has been generally referred to the combined operation of several different causes, which are all, however, reducible to these two—*distance from the equator*, and *height above the level of the sea*; so that latitude and elevation form the great basis of the law of local climate; and the modifications of this law by other causes have generally but a partial and limited influence.

5256. The climate of every individual country may be regarded as local, in reference to that of all other countries in the same degree of latitude. Thus, islands are warmer than continents. The E. coast of all countries is colder than the W. The W. coast is moister than the E. Countries lying to the windward of great ranges of mountains, or extensive forests, are warmer than those to leeward. Small seas are warmer in summer and colder in winter than portions of great oceans, they being affected by the condition of the surrounding land. Low countries are warmer than high, and level plains than mountainous regions. Places situated upon the same mountain-chain, nearly in the same latitude and at the same height, have often very different climates. The temperature which would be proper to a place perfectly isolated, is necessarily modified by a considerable number of circumstances. Thus,

the radiation of heated plains of considerable extent, the nature of the colour of the rocks, the thickness of the forests, the moisture or dryness of the soil, the vicinity of glaciers, the prevalence of particular winds, hotter or colder, moister or drier, the accumulation of clouds, are so many causes which tend to modify the meteorological condition of a country, whatever be its geographical position. In no other part of the globe is the diminution of temperature occasioned by a rise of level above the sea more remarkable than among equatorial mountain ranges; and it is not without astonishment that the European, leaving the burning districts which produces the banana and cocoa nut tree, frequently reaches, in the course of a few hours, the barren regions which are covered with everlasting snow.

5257. There is a phenomenon which has a material effect on local climate—the darting of cold pulsations downwards from the upper region of the atmosphere, and of warm pulsations upwards from the earth. This is different from radiant heat. Pulsations of temperature are detected by a recently-discovered instrument called the *æthrioscope*; and although the experiments with it have as yet not been sufficiently numerous to insure implicit confidence in its powers, the experience of all who have paid attention to the varieties of circumstances which affect local climate intimates that many influences exist, in the atmosphere, to produce complicated effects which cannot be indicated by the instruments in common use.*

5258. From all these facts and reasonings, it appears that a slight difference of elevation in a mountainous district of this country, which has so high a parallel of latitude, may make a considerable difference on the local climate; and that, other things remaining the same, that farm which is highly elevated has a greater chance of being affected by changes of climate than one on a lower level; yet local circumstances have a material influence in rendering the general position of any farm less desirable, such as, vicinity to a lake or marsh, or a leeward position to a hill or large wood in reference to the

* *Encyclopedia Britannica*—art. *Climate*, 7th edition.

direction from which the wind generally blows—both which tend to lower the temperature below that of the mean of the country. Any position in a long narrow valley, or on the haunch of a large isolated hill, or in a pass betwixt two mountains separating plains, is more subject to violent gusts of wind than the mean of the country, the wind acquiring an accelerated velocity in such localities. An elevated table-land being subject to a lower temperature and higher winds than a plain of the same extent on a lower level, is to be avoided. The windward side of a hill or large wood, or on flat ground backed with hills and woods to the N. and E., insure a higher temperature and less wind than the mean of the country. An extensive plain or valley, through which no large river passes, or in which no large lake or wood exists, is very little subject to violent winds. In exposed situations, the snow lies long, and the winds are keen; while in sheltered positions the snow soon disappears, and the wind is gentle. These different circumstances produce a sensible effect on the local climate of a small country like Great Britain; and varied as it is in its physical geography, and surrounded on all sides by water, they have the effect of dividing the country into as many climates as there are varieties of surface and differences of position. Such local influences, in most seasons, have a greater effect on the time of growth, quantity and quality of the produce of the earth, than the general climate of the country; although the latter exercises a predominating influence in some seasons, by excessive heat or rain, so as to overcome all local influences, and to stamp a generality of character over the season.

5259. I may here advert to a generally received opinion among farmers and others who are much exposed in the air, that the weather of Great Britain has changed materially within the memory of the present generation. I am decidedly of this opinion; and I observe that Mr Knight, the late eminent botanical physiologist, expressed himself on this subject in these words:—"My own habits and pursuits, from a very early period of my life to the present time, (1829,) have led me to expose myself much to the weather in all seasons

of the year, and under all circumstances; and no doubt whatever remains on my mind, but that our winters are generally a good deal less severe than formerly, our springs more cold and ungenial, our summers—particularly the latter part of them—as warm at least as they formerly were, and our autumns considerably warmer." He adds, "I think that I can point out some physical causes, and adduce rather strong facts in support of these opinions."

5260. Of the physical causes of these changes, Mr Knight conceives that the clearing of the country of trees and brushwood, the extension of arable culture, and the ready means afforded by draining to carry off quickly and effectually the rain as it falls, have rendered the soil drier in May "than it could have been, previously to its having been enclosed and drained and cultivated; and it must consequently absorb and retain much more of the warm summer rain (for but little usually flows off) than it did in an uncultivated state; and as water, in cooling, is known to give out much heat to surrounding bodies, much warmth must be communicated to the ground, and this cannot fail to affect the temperature of the following autumn. The warm autumnal rains, in conjunction with those of summer, must necessarily operate powerfully upon the temperature of the succeeding winter." Hence, a wet summer and autumn are succeeded by a mild winter; and when NE. winds prevail after those wet seasons, the winter is always cloudy and cold, but without severe frosts; probably, in part, owing to the ground upon the opposite shores of the Continent and of this country being in a similar state. The fact adduced by Mr Knight in support of this opinion is that of the common laurel withstanding the winter, notwithstanding its being placed in a high and exposed situation, and its wood not being ripened in November. "Supposing the ground," continues Mr Knight, "to contain less water in the commencement of winter, on account of the operations of the drains above-mentioned, as it almost always will and generally must do, more of the water afforded by the dissolving snows and the cold rains of winter will be necessarily absorbed by it; and in the end of February, however

dry the ground may have been at the winter solstice, it will almost always be found saturated with water derived from those unfavourable sources; and as the influence of the sun is as powerful on the last day of February as on the 15th day of October, and as it is almost wholly the high temperature of the ground in the latter period which occasions the different temperature of the air in those opposite seasons, I think it can scarcely be doubted that, if the soil has been rendered more cold by having absorbed a larger portion of water at very near the freezing temperature, the weather of the spring must be, to some extent, injuriously affected." Hence, the springs are now more injurious to blossoms and fruits than they were thirty years ago. Hence, also, the farmers of Herefordshire cannot now depend on a crop of acorns from their extensive groves of oaks.*

5261. Since elevation of position above the sea is a material element in determining the local climate, it is of some importance for you to ascertain the height of your farm above the level of the sea. If you know that by other means—namely, by trigonometry—the information is sufficient for your purpose; but should you not be acquainted with its elevation, which is usually the case with farmers, the mean height of the barometer will ascertain it by a series of simple observations, made at a given time, over a year or more. For example, "the sum of one year's observations, made at 10 A.M. and 10 P.M. in 1827, was 21615.410 inches; and this number, divided by the number of observations, 730, or twice the number of days in that year, gave 29.610 inches as the mean height or changeable point of the barometer."† Now, taking the mean height of the barometer at 29.948 inches at the mean level of the sea, where the atmosphere always indicates the greatest density, deduced from nine years' observations at the mean temperature of the air, with a range from 28 inches to 31 inches, it is seen that the instance adduced above of 29.610 inches gives .338 of an inch less than the mean, which, by the table in (86) indicates an elevation of the place of observation of about 265 feet above

the mean level of the sea. It is from the mercury being above or below this point of 29.610 inches, which is the supposed mean of your farm, that you are to conclude what weather may be expected there, from the changes of the barometer. That same elevation will also make a difference of half a degree in the mean temperature of the year.

5262. On looking at a farm, it is your duty to apply the principles adduced above, as regards climate, to its particular circumstances—a mode of judging which is too often neglected by those who value farms, and is the cause of much discontent to the tenant, after he has discovered the character of its climate by dear-bought experience. Let us run over the particulars which require a serious attention on this subject. The *temperature* of the locality has a considerable influence on all crops. The late Professor Playfair assumed that the lowest temperature at which corn will vegetate is 40° , and that corn will not ripen below a temperature of 48° . He proposed to date the vegetating season from 20th March to the 20th October, and considered 56° as the mean temperature of a good vegetating season.‡ It may therefore be assumed, that if the mean temperature of a place, between March and October, is below 56° , it is not likely to bear good crops. The *altitude* of a place affects its temperature materially. We have seen that an altitude of 590½ feet makes a difference of 1° of mean temperature—making the effect of elevation the same as an increase of latitude. This is a point which is very liable to be overlooked in the interior of the country, where an elevation is insensibly gained much beyond belief. The country may appear pleasant, and everything indicative of a good climate, but, on inquiry, it may be found to be 600 or 800 feet above the level of the sea—an elevation in which wheat will not ripen, and at which even barley will be a precarious crop, in many seasons. At such an elevation it is not improbable that one or two crops may be lost in the course of a lease of 19 years. In such situations, the *daily* range of the temperature is great, descending low at

* Knight's *Horticultural Papers*, p. 307-9. † *Quarterly Journal of Agriculture*, vol. iii. p. 3.

‡ *Transactions of the Royal Society of Edinburgh* for 1800.

night, after having indicated a high degree during the day; and every farmer knows that a low temperature during the night has a most injurious effect upon the crops: for warm nights, in effect, double the number of warm days, and a continued existence of heat saves plants from the injury arising from checked growth by cold. In travelling at night in England in summer, there is no circumstance so striking to a Scotsman, as to find the air as warm as it usually is in the daytime in his own country. Hence, the harvests in England are always much earlier than in Scotland; and such a superiority in climate will more than counterbalance superior skill. The distribution of rain in the vegetating season—it falling frequently being less favourable to vegetation, than in greater quantities at longer intervals—is deserving of inquiry; also, whether the locality is affected by *vapour*, thereby experiencing more cloudy than clear days. The lowness or highness of the *dew point* has a material effect upon crops. The relation between local climate and the growth and productiveness of the different crops, you thus see, is deserving of your utmost attention. What effect it has upon the money-rent of land it is not easy to determine; but that land so situate is of less value than that which is not affected by such local influences, cannot admit of doubt.

ON THE JUDGING OF LAND.

5263. Land cannot be judged of at all seasons, or at any given period. It may be covered by snow, when it is shrouded from all inspection. It may be saturated by rain, when it is impossible to walk over it. It may be hard frozen, when it will not yield to the foot or the spade. It may be covered with a crop, when the texture of the soil cannot be examined. Practically, the soil cannot be examined when placed under any of these circumstances.

5264. When the soil is well known, perhaps the best season to inspect a farm is just before harvest, when every species of crop is in the fullest luxuriance—in which case you do not require so much to know the nature of the soil, as the condition it is in; and if it be out of condition,

the crops will exhibit unequivocal symptoms of its poverty.

5265. When the farm is unknown to you, the best season to look at it for the first time is in spring—in March—in dry weather—after the largest proportion of the soil has been turned over by the plough, and when its natural state, in regard to dryness and wetness, and even condition, cannot be concealed. This is the only season to indicate whether or not the soil is in need of draining.

5266. But when you look at a farm, to have it valued for a lease, it is impossible for you to undertake such a task, until you have farmed practically, for a number of years. The only safe course for you is to obtain the assistance of an experienced friend, who is well acquainted with the part of the country in which the farm is situate; or any one well versed in farming will answer the purpose.

5267. I should mention, that it is considered amongst farmers a dishonourable act to look at a farm until you are assured it is in the market, by the knowledge that the tenant is to leave it, or by advertisement in the newspapers—otherwise it is an unfeeling act, and regarded as equivalent to taking the farm over his head.

5268. On judging of the soil, the subsoil requires as much attention as the soil, and it cannot be reached but with a spade. Pits must be dug through soil and subsoil, to ascertain the nature and texture of both, and whether they are similar or dissimilar in character. Most commonly they are dissimilar; for, although they may have been originally similar, cultivation and the application of various manures, and the effects of the roots of growing plants, will have so changed the properties of the upper soil as to render it quite of a different character from the subsoil. From the nature of the deposit in the Carse of Gowrie, it is probable that the agricultural soil and subsoil (344) were at one time similar, and that any difference remarked now is the effect of cultivation only. The following analysis of the soil and subsoil by Dr Anderson, Chemist to the Highland and Agricultural Society, of a soil farmed by Mr Walker

Rannie of Inchyra, on the bank of the Tay near Errol, will show what I have just stated:—

	Soil.	Subsoil.
Potash,	2.8001	2.1761
Soda,	1.4392	1.0450
Lime,	0.8300	1.2756
Magnesia,	1.0200	1.3938
Peroxide of iron,	4.8700	6.2303
Sulphuric acid,	0.0911	0.0396
Phosphoric acid,	0.2400	0.2680
Carbonic acid,	0.0500	...
Chlorine,	0.0098	0.0200
Alumina,	14.0400	14.2470
Silica,	63.1954	61.6358
Organic matter,	8.5508	6.8270
Water,	2.7000	4.5750
	<hr/>	<hr/>
	99.8364	99.7032 *

It will be observed that the soil contains more potash and soda than the subsoil, which have no doubt been added to it by the ingredients employed as manure. This soil has never been known to have been limed, and hence cultivation has taken away a portion of its lime; and the same remark applies to its magnesia. No doubt, also, that cultivation would decompose a part of its peroxide of iron. The silica would be increased by cultivation, and so would the organic matter even in greater proportion; and the subsoil may be supposed to have always more water in it than the soil, part of the moisture of which is constantly exposed to evaporation. (457.)

5269. A considerable diversity of soil may be expected to be found on most farms. Those which exhibit the most uniform soils are on diluvial deposits, as in the Carse of Gowrie, as also peaty soils on high pastoral districts; and the greatest diversity is presented by sandy and clay soils, both which may be found in the same farm. Diversity of soils is no objection to a farm, as it admits of variety in the rotation of cropping, a change of crops, and a chance for them to meet the exigency of a difference in seasons. To possess a diversity of soil in the most convenient form, they should occupy separate fields.

5270. The soils commonly met with in farms are, a tolerably deep clay loam resting on a porous or a retentive subsoil. That which rests on a naturally porous subsoil is a good soil for every kind of crop, whether green or of grain, and may be

easily rendered fertile, and kept so by the numerous manures now at command. What is on the retentive subsoil, requires draining before it can be rendered permanently fertile with any kind of manure; but, on being drained and manured, it is capable of yielding good crops, whether green or of grain.

5271. A thin hard clay is often met with, and almost always on a retentive subsoil. This invariably requires draining and manuring, and at first, even after the draining, requires much labour to render it loose and friable. Ultimately it becomes a tolerably good soil, and will bear fair crops every year, provided it is liberally manured in the course of the rotation.

5272. A thin loose soil, resting on a retentive subsoil, is also often met with. It requires draining and manuring, but not so much work as the last mentioned. It is weak in constitution, and hungry as to manure, nor is it easily satisfied—not that it has capacity to take a large dose at a time, but will take it frequently. A little mixture of the subsoil by trench-ploughing does it much good, and ultimately, by kind treatment, in eating off turnips with sheep, it will carry fair crops.

5273. A soil is not unfrequently met with which is deep enough, in as far as the operation of the plough is concerned, but is of black colour. It is deaf, very soft, and apt to be carried forward on the breast of the plough. The straw grown by this soil is thick enough, but soft and brittle, and apt to lodge in wet weather; and the grain, though sufficiently abundant, is thick-skinned and light. Such a soil, though deep, often rests upon retentive clay, and is easily affected by wet, although it will withstand drought for a long time. This soil has at one time been a moor, and yields crops readily at first, but does not continue to improve. It is much improved by thorough-draining, and trench-ploughing the subsoil amongst it.

5274. A soil of quite an opposite character may be found—a sharp gravel upon a

* *Transactions of the Highland and Agricultural Society, July 1850, p. 296.*

gravelly porous subsoil, which is admirably adapted to raise turnips with bone-dust, forms the best lair for sheep on turnips in winter, and never fails to lay thick fat on the kidneys. Both straw and grain from this soil, though not abundant in quantity, are of fine quality.

5275. The most uncommon soil is a deep unctuous clay of uniform texture, both on the surface and under the reach of the plough. It is capable of growing large crops of grain and straw, and is less adapted for green crops. It is difficult to work, though this property might be greatly altered by draining.

5276. Another kind is deep, dry, rich alluvial deposits, either in flats along the banks of rivers or in the bottom of valleys, constituting haugh-land. This soil is equally fit to grow grain and green crops, is easily maintained in a high state of fertility, and is easily wrought. It requires little or no draining.

5277. A thin peaty soil is found in large extent upon many of our pastoral farms, and is much improved in its capability to grow natural pasture by sheep drains upon and under the surface. When so drained it is rendered sound land for sheep; when not, they are apt to take the rot upon it in certain seasons.

5278. Boggy soils are also met with to pretty large extent in parts of the country in hollows, whether on a low level or elevated plain. They are of no use to the plough, or for live-stock, until first drained; and then most of them yield large returns in grain, green crops, or in meadow.

5279. Pure sands are met with in certain parts adjoining the margin of the sea, or on estuaries. When cultivated with the plough, they yield pretty good crops with a constant supply of manure; and when in pasture, supply a short sweet herbage for sheep.

5280. All these varieties of soil are judged of in the same manner. Every field must be walked over, and when diversity of surface exists, the knolls and hollows must be traversed. On the knolls

will be found the thinnest, and in the hollows the thickest part of the soil. The spade thrust into the bottom of an open furrow will show at once whether the soil is thick or thin; and if thick in the furrow, it cannot fail to be so on the ridge. It is not easy by words to describe the characters of a good or bad soil, or to point out the distinction in regard to their state of fertility. It is only their physical properties that we can ascertain; and as I have already given these very minutely, from (333) to (343,) they need not be repeated here; and to judge of these the land requires to be in the ordinary workable state—not saturated with rain, nor frozen hard, nor burnt up with drought. All clay soils feel hard, or rather firm under the foot; loams feel soft. Smooth deep soils feel as in walking over a thick carpet, and thin soils as over a thin one on a hard floor. Soils in high condition (349) possess friability; in poor condition, they are either hard or too loose. The mark of the foot in soil in good condition is soon obliterated, by the elasticity of its particles; but when in poor condition, it is either indelible or remains a long time impressed. In low condition, soils seem bleached by the weather, are more diversified in colour, are in want both of labour and manure, and are generally foul with weeds. Very thin clays (350,) hungry, (351,) and deaf soils (356,) are of doubtful character, and yield returns only according to the artificial condition into which they are put. As to this condition, it will be requisite to ascertain whether or not they have been drained, wrought, and limed, and well farmed; and if they have been so treated, and still indicate weakness, want of stamina, exhaustion, or a bleached appearance, it may be concluded that they will bear little improvement; but should they have been neglected under these symptoms, draining, manuring, and good tillage may make them assume a much better appearance in the course of a few years.

5281. If a considerable variety of soil exists on the farm, it should be observed whether they occupy different fields, which is a favourable arrangement, or whether the same field has a great diversity of them, which will be found troublesome. The amount of the good and bad soils

should be summed up separately, and seen which prevail. If the bad only occupy from a fourth to a third of the whole, the farm may be regarded as a good one, and its character for excellence will depend on the quality of its good soil; but should half of it be bad, the proportion is too great for the good soil to do justice to itself, and assist the bad; and where the proportion of bad increases beyond the half, the value of the good falls very rapidly. Whether on good soil or bad, it is better to succeed a slovenly farmer than a tolerably good one: for the latter has sufficient skill to make the land do its utmost, with the least means of amelioration, and to wear it out, and no state of land is so difficult to recover its tone as when worn out. A slovenly farmer may leave the land in a dirty state, and unpleasant to the eye, but he has rarely the skill to wear it out. But the fortunate chance is to succeed a farmer who has brought his farm into, and has kept it, and leaves it, in full bearing.

5282. Part of the farm may be in an uncultivated state, which is not the most objectionable part in a worn-out farm. Its soil will be fresh, and will be brought to bear well sooner than old worn-out land. This portion may be useful in permitting the older land to lie in grass to recruit for a longer period than an ordinary rotation, whereby it will recover its tone, and bear better crops afterwards.

5283. The most desirable appointments for a farm of mixed husbandry to possess are these:—Extent from 200 to 800 acres. Soil, deep light clay-loam, capable of bearing turnips and wheat, incumbent on a naturally porous subsoil. A turnpike and a parish road crossing at its centre. Fields rectangular, and comprehending from 20 to 30 acres each. Fences of thorn hedges. Ground gently sloping, or undulating to the S. Elevation not exceeding 200 feet above the sea. Water from springs or rivulets, accessible to every field. Steading situate near the centre of the farm, capacious enough to contain all the cattle in winter, and convenient for every barn-work. Two or three paddocks near the steading for calves, &c. Comfortable farm-house and neat garden, not far from the steading, and

the public road. Shelter by high land or woods from the N., whence come cold winds and frost; and from the SW., whence blows the strongest and most shaking wind. Market town of a moderate size to supply the luxuries of life. Coal and lime, and extraneous manures, at a short distance from a railway station, which if on the farm, so much the more convenient. Grinding-mill of wheat and oats in the vicinity. It is barely possible for one farm to possess all these advantages, and it is not possible for every farm of a country to possess them all; but the more of them are conjoined, the better for the farm. It is not easy to determine the difference in the money value, caused by the presence or the want of all these conveniences, but it cannot fail to be considerable.

ON ESTIMATING THE RENT OF A FARM.

5284. All the varieties of soil mentioned above are to be found on the various sorts of farms existing in this country. It is not to be supposed that the value of all these soils is to be estimated on the same principle, since some only produce grain, and others only support live stock; but whatever may be the nature of their products, it is clear that the value of every soil must depend upon their quality and amount.

5285. The fixed money-rent of arable land may be estimated by taking the gross amount of corn the farm is capable of growing, and the number of live stock it can fatten in the course of a year; and deducting therefrom the expenses incidental to cultivation and the care of stock; and on allowing a reasonable percentage on the capital invested by the tenant, the remainder is regarded as the sum payable to the landlord in rent; but as this last sum, on this supposition, would vary according to seasons, a fixed one is substituted in its stead, as the rent to be annually paid for the farm. This mode of estimating the rent is applicable to carse farming, to farms in the neighbourhood of towns, and at a distance from towns where the mixed husbandry is not practised.

5286. The fixed money-rent of a pas-

toral farm may also be estimated by the gross number of stock, whether of sheep or cattle, or of both, the farm can support in the course of a year; and in deducting the expenses attending the rearing of the stock, and a percentage on the capital invested in them, the remainder is the rent due to the landlord. But as this sum would also fluctuate, as well as that in the case of the arable farm, the practical result is either to pay a fixed sum annually, or a sum per head for all the stock the land can support during the year.

5287. The fixed money-rent of a dairy farm may be estimated by the gross amount of butter and cheese it will yield in the course of the year; and, on deducting the expenses attending its management, and the percentage of the capital invested in it, the remaining sum should be given to the landlord in rent; but, as in the other cases, a fixed sum is named for the fluctuating one, or a sum is payable for every cow the farm will support during the year—in which case the landlord has the farm in his own hands, and supplies the cows with food.

5288. The fixed money-rent of a farm for mixed husbandry may be estimated by taking the gross amount of the produce in grain, and of the draft cattle and sheep, and wool sold; and, after deducting the expenses and percentage of capital, the sum to be paid in rent is found.

5289. Were the price of farm-produce a fixed element, a fixed money rent would be most convenient for the tenant to pay, and the most equitable for the landlord to receive; but as price has fluctuated to an inordinate degree in the course of years—from 1771 to 1842 that of wheat has absolutely fluctuated 364, of barley 391, and of oats 314 per cent—and as price has gradually fallen from the end of the war in 1815 to the present time, 1850, it seems reasonable, on the part of the tenants, to desire to have the rents so adjusted as to become the true exponents of the fluctuations in price—oftener at least than the fixed money-rent has hitherto been, if it cannot certainly be done at all times.

5290. The only part of the farm-pro-

duce upon which the fluctuations in price can be made to bear is the grain, whether it be of one kind or of all the kinds usually cultivated on the farm. Wheat was at first chosen as the grain whose price should regulate the fluctuating portion of the rent; because, although the absolute fluctuations in its price were great, the relative fluctuations in reference to the price of the other sorts of grain were not so great, not exceeding 100 per cent. But on many farms no wheat was raised, and the possessors of them were naturally apprehensive that the price of a grain which they did not cultivate would not fairly represent the price exigible on the sort or sorts of grain which they did raise. At the same time, the price of wheat could not be disregarded, as it no doubt fixes the relative prices of the other sorts of grain; and that species of grain, besides, constitutes a large proportion of the crop of the kingdom. All inconveniences in the matter were disposed of by adopting the price of the three grains most commonly grown in the country—wheat, barley, and oats—and their cumulative prices per quarter afford data by which to estimate the gross value of the grain raised on the farm.

5291. But a rent paid entirely from the fluctuating price of grain is satisfactory to neither landlord nor tenant. When the price sinks very low, either from an extraordinary crop or from extraordinary competition by the importation of foreign corn, the landlord will receive less than his just proportion of the crop; and, on the other hand, when the price rises to a great height, from a large deficiency in the crop at home, together with a limited importation from abroad, the tenant will pay a much larger sum in rent than he can realise from his crop.

5292. A compromise seems necessary to meet the cases of both parties, and it is effected in this manner:—Let one half of the estimated rent be always paid in cash, and the other half in grain, the value of which at the cumulative price per quarter of wheat, barley, and oats, fixed by the fairs, or the general average prices of the country, shall be equal in amount to the half paid in cash at the time the rent was estimated. The grain half of the rent will

fluctuate thereafter with the average price, as it rises or falls. For example—supposing the rent of the farm had been estimated at £1000 a-year, and that the average prices of grain at the time were, for wheat 40s., barley 22s., and oats 16s. per quarter, so that about 128 quarters of each sort of grain at those prices respectively would make up half the rent, thus:—

The Rent,					£1000 0 0
In Cash,					
In Grain—					
Wheat, 128 qrs. at 40s.	£256	0	0		
Barley, 128 .. 22s.	140	16	0		
Oats, 128 .. 16s.	102	8	0		
	128	78s.	499	4	0
			499	4	0
				999	4

In future, no change would take place in the £500 paid in cash; but the £499, 4s., raised from the 128 quarters of each sort of grain, would vary every year, more or less, with the average prices. Or, the conversion of a money rent into a grain one may be done in another way. Suppose that the £1000 a-year is 25s. the acre, then 78s., the cumulative price of wheat, barley, and oats, per quarter, : 8, the bushels in a quarter, : : 25s. : 2.564 bushels of each kind of grain, which, at the respective prices per quarter, give 24s. 11 $\frac{3}{4}$ d. per acre.

5293. The rate of interest on money should enter as an element in the calculation of rent; because, the rate of profit derivable from the capital invested in the farm should vary with the general rate of interest. Thus, if the farmer expects 15 per cent on his invested capital when the rate of interest is 5 per cent, like other people in trade, he should be content with 12 per cent when the rate falls to 4 per cent. If the rates of profit and interest bear a different relation in the country, the farmer, of course, must submit to the general conditions of trade.

5294. But rent is seldom estimated by such a roundabout method, since experience has taught practical men to come to a conclusion at once, as to the capability of every soil, *in the condition they view it*; and it is this criterion of the maturity of their judgment that stamps an intrinsic value on their advice. They estimate the acreable amount of grain which the land will produce, and the quantity of stock it will support, in the condition they see it;

and, calculating these at the current prices, the total value of the produce is ascertained, and the rent determined which the farm can afford to pay. Although they estimate the rent of the land in its existing condition, they judge, besides, whether the land is capable of producing more by better farming, and give the rent a latitude in the offer to be made. Upon this last uncertain element, however, many rents have been offered beyond the intrinsic value of the land; and when seasons become unpropitious, or prices fall, or the new tenant proves himself an indifferent farmer, the rent he promised is soon found to be too high for his skill.

5295. "One of the chief arguments in favour of a constant money rent," says an intelligent writer on this subject, "in opposition to every kind of fluctuating rent, is this—that, however ill the former may be adapted to the times, or however widely it may differ from the natural rent of the farm, the tenant, from knowing its exact amount, can regulate his other expenditure accordingly, and the proprietor receiving such rent knows exactly what he has to spend. Now, as to the tenant, it appears to us that he is better enabled to regulate his expenditure by knowing the quantity, or nearly so, of his produce—say the number of stacks of wheat which he must lay aside as rent—than by knowing the sum of money when he is yet ignorant what proportion that sum will bear to the gross return from his farm. As regards the proprietor, again, we conceive that the virtual value of his income is fully as steady when made up of produce-rents as money-rents. This results from the fact that the staple products of the country, such as corn, butchers' meat, and wool, are the chief regulators of the value of money. Thus, if the proprietor's income be regulated by these, or even by the most important of them, he may calculate on being able always to obtain out of it pretty nearly the same quantities of the necessaries, and even of the luxuries of life. But even if it were some advantage, in ordinary cases, for both parties to know the amount of money in place of produce which they have to give and receive, such knowledge would be of little consolation to the tenant, when that money becomes double of what he would have to give, or

to the proprietor, when it is only half of what he would have to get, were a new bargain to be made. That such cases have often happened with farms let in fixed money-rents, during the last half century, no one in the least acquainted with the history of British agriculture will deny. There appears, therefore, to be no such advantage in a constant rent over a fluctuating one, from the sure fixedness of the one over the variableness of the other, as to make us prefer the former, if the latter can be better proportioned to the means of paying it.

5296. "The propriety of making the rent fluctuate evidently depends much on the duration of the agreement, whether as originally determined, or as tacitly prolonged. The natural rent of land for a single season can be calculated with a probability of sufficient accuracy to justify the offer and acceptance of a fixed rent for it. For a period, however, such as that to which leases usually extend, it is difficult to estimate rents with an approach to accuracy, even during the most undisturbed progress of legislation and of agriculture. During the extraordinary changes which this country has experienced in its agricultural, as well as commercial, political, and social condition within the last half century, the calculation of rents for the period has been little else than wild conjecture, and the pecuniary condition of proprietors and tenants have in many instances been reversed.

5297. "It is obvious that excessive gain or loss to either party—both prejudicial to the advancement of agriculture—would have been avoided, or at least greatly modified, had rents been proportioned to the balance of income over expenditure, out of which balance rent is payable. The necessity of making rents fluctuate was thus most felt where leases were granted. It was therefore in Scotland, and the parts of England where this mode of tenure prevailed, that a system of rent regulated by the price of grain originated, and still exists to a considerable extent." *

5298. A carse clay-farm being entirely

engaged in raising corn, a grain-rent seems almost indispensable for it, to protect both landlord and tenant from the great fluctuations which beset the corn-market.

5299. A pastoral farm has nothing to do with a grain-rent, its principle of rent being so much money per acre for the pasturage, or so much money per head for every sheep or ox it can support.

5300. When calculated in the manner I have described, rent may be regarded as the *natural* value of the land. It is based on the supposition that the land is worth the sum at the time of the estimate. It also takes for granted that the farm is complete in all its appointments—the house, the steading, the fences, and also that the land is in fair condition. It may also be regarded as a rack-rent—that is, the highest value the land can bear at the time.

5301. But when these appointments are incomplete—the house bad or wanting—the steading incommodious—the fences dilapidated, or the land in wretched order,—the rent must be modified to suit the particular state of the farm. What proportion of the rent ought to be deducted for a bad farm-house, a bad steading, bad fences, it is not easy to decide; but from 2s. 6d. to 5s. an acre may not be unreasonable. And for bad condition of the soil, from 5s. to 10s. an acre is not too great a deduction, since it may require from L.5 to L.10 an acre to put it into heart. The estimate of the deterioration by such exigencies, in the shape of pecuniary deductions, converts the rent into a *covenanted* one, and it assumes that character also when the tenant undertakes to build, or fence, or drain; but when the landlord undertakes to supply the deficiencies, the covenanted rent is still acted upon, because it is a covenanted one, and a percentage is paid over and above by the tenant, as the deficiencies are all remedied; but whenever the entire rent, including the percentage, is payable, it becomes the natural one.

5302. Both the natural and covenanted rents may be either constant or fluctuating; and I have shown above that the partially fluctuating rent is the safest for the tenant.

5303. But the method of arranging the grain rent, as enunciated above, (5292,) is not quite correct, because it includes the value of the stock, which ought not to be regulated by that of the grain; for, although a correspondence more or less close may no doubt be observed, over an average of years, between the values of grain and stock, yet there is often such a discrepancy between their prices in different seasons, as to render a rent calculated from the one a very false representation of that payable from the other. The natural rent payable for

stock is the value of the stock in the market, or the value of the stock-feeding crops, such as turnips, grass, hay. The market value of the stock would be extremely difficult to ascertain, since stock are brought into the market at all ages, and in all conditions, and both dead and alive; but the value of the stock-feeding crops is as easily estimated as that of grain itself, and their fluctuation also, as easily estimated as those of grain. On these accounts, the value obtained by selling the stock-feeding crops to be eaten on the ground and in the steading, ought to determine their portion of the rent; and this mode would have the advantage of being a simpler guide than the value of the stock sold in any one year, because their intrinsic value seldom corresponds exactly with the money received for them.

5304. From what has been said, it is price alone that has hitherto been attended to in regulating grain rents. "This we consider a glaring defect in the system now followed," observes the writer formerly quoted, "as applied to the present, and more especially to what we hope will be the future state of our grain markets. We consider such a system in many instances to be unfair to the proprietor, and in others to the tenant. It is unfair to the proprietor when the crop of the county, and therefore presumably that of his own property, exceeds the average quantity of many years' crops in a greater degree than its price falls below the average; and for the tenant, when the crop falls under an average quantity to a greater degree than its price rises above the average. But, suppose the fluctuations in price to be exactly the reverse of the fluctuations in quantity, the present method is far from being a proper one for adjusting rent; because, were the price to fall in the same proportion as the acreable produce increased, the tenant ought still to have the same *income* from his farm, which being obtained at a smaller *outlay*, he would have a greater balance to pay rent from a large cheap crop than from a small dear one. Hence the present system of grain rents is particularly unfavourable for the landlord when the crop is abundant and cheap, and equally so for the tenant when scanty and dear. Its only proper and justifiable tendency seems to be, to give the proprietor a share in the benefit from a rise in prices, when the rise is not produced by a deficiency of crop, and to protect the tenant against the entire loss from an unlooked-for reduction of price through an inundation of foreign corn." * This latter casualty the tenant was guarded against by protective duties; but now that they are removed, no such guard exists to protect him from any and every casualty that may befall price. The sooner, therefore, that the mere element of price, in estimating grain rents, is abandoned, the better for both landlord and tenant.

5305. The only remedy for this danger, which is now imminent under Free Trade, is to take the *acreable average of the county, as well as the average price of the regulating grains*, as the only

true and proper elements in the calculation of fluctuating grain rents; and in like manner, in calculating the fluctuating rents payable on cattle and sheep, the *average acreable value of the stock-feeding crops throughout the county* ought to be taken rather than the average price per stone of beef, mutton, and wool. I do not say that this plan would entirely compensate for the great depression of price occasioned by free foreign imports. I think it would not; but it would certainly cause less loss to the tenant than any system of grain rents in existence, and much less than any existing constant money rents.

5306. The difficulty of determining the statistical facts of the *annual average acreable produce of grain and of stock-feeding crops in each county*, is the only considerable obstacle to the adoption of this theory of grain rent in practice; and it is evident that, until those facts can be ascertained, it will be impossible to institute the system of grain rent recommended.

5307. It may be well to recapitulate the advantages attending the recommended system, as well as to meet the objections against it. 1. It would give the landlord and tenant their just shares of profit and loss from the general improvement of agriculture, without influencing the gain or loss due to the tenant for his peculiarly good or bad management. 2. When his land is let on a constant money rent, the landlord's only benefit from the inward produce of the country, on account of general improvements in agriculture, depends on the frequent disproportionate increase in the value of money. When it is let on the present mode of grain rent, an increased produce by such means is rather a loss than a gain to him, by its reducing the price of grain more than that of other commodities, and, consequently, it lowers his rental more than it raises the value of money. I see no reason why the proprietor should not share with his tenant in the variations of the productiveness of the soil, whether occasioned by the weather or by the application of science, as well as in the variation of the prices. 3. By it landlords would derive the additional advantage of choosing skilful tenants, who, by increasing the produce of their farms, would raise the average produce of the district, and consequently establish the means by which their rents would be increased. 4. An inestimable benefit would result to the community from the adoption of this practice, by giving proprietors a more immediate pecuniary interest in increasing the produce of their estates, and of the country around them, as also by its thus creating a strong inducement for them to reside on their estates. 5. By proportioning their income to the state of the country, such a mode of rents would deprive proprietors of the most plausible argument against granting leases, and would, therefore, induce the practice, with its numerous good consequences, to be greatly extended.

5308. The only objection against the proposed system is, that by reducing rent as the average

* *Journal of Agriculture*, January 1846, p. 145.

produce diminishes, a premium on bad farming would be established. Such would no doubt be the case were the rent merely to vary with the produce of the farm for which it is paid; but when it is mainly dependent on the produce over a large district, the objection is not a good one; for the influence of a scanty crop of one farm in reducing the average of the district would be so small, and the loss from it to the farmer so great, that the increasing productiveness of his farm would be as much an object to him as any other system of payment, and it would thus present no temptation to relax his energies.

5309. After so lengthened an exposition of the grain rent, it may be deemed superfluous to adduce any more instances of it; but the one enunciated by the late Dr Coventry, having found considerable favour amongst agriculturists, it may be proper to mention it. He constructed a formula on the produce of oats—the species of grain most commonly cultivated in Scotland—and the terms of the formula were: Divide the produce per acre in oats by two, and multiply the product by one-tenth of the produce. Thus:—

Take the produce of oats at $\frac{8}{10}$ quarters per acre.

Which divide by 2 is	4
Multiply 4 by $\frac{1}{10}$ of 8,	.8
And the amount is,	3.2
	--

That is 3.2 quarters per acre for rent, which at 16s. per quarter, gives 51s. 2d. in money per acre for rent. Carrying out this rule to various amounts of produce per acre, it appears that land capable of yielding 10 quarters per acre pays half its produce in rent, while that which only yields 2 quarters per acre pays only one-tenth of its produce in rent. The principle upon which this great difference in the proportions of produce is founded is, that the cost of labour in managing land which only grows 2 quarters per acre is fully greater than that of labouring and managing land which yields 10 quarters per acre, whilst the return is only 1 : 5. Now it seems but fair, that if, with poor land, the tenant has due allowance afforded him, on account of its inferiority, the same consideration should be awarded to the landlord, on account of the superiority of the land he has to be let. Were this principle carried to an extent much beyond 10 quarters, too great a proportion of produce would seem to accrue to the landlord for rent; but it might, perhaps, hold good, to the extent of productiveness we are accustomed to receive in this country.

5310. One advantage this rule is said to possess is, that should the capability of the land to produce what is estimated be correct, the mode by which the quantity taken for rent is apportioned, will be found never to charge the land more than it can fairly be conceived to bear.

5311. The conversion of a money rent into a

grain one is by the same rule as that already given in (5292).*

5312. Not unfrequently one sees in the newspapers schemes for calculating the value of a given crop per acre by the prices as they fluctuate. When such schemes are intended for England, wheat alone is the grain used as the basis of calculation. Such schemes usually display little ingenuity. A pivot, as it is called, is fixed upon, and it is any sum which the concocter may choose to adopt. As the price of wheat rises or falls one shilling a quarter, the rent for a given number of bushels per acre rises or falls two shillings, and as the produce increases or diminishes by one bushel per acre, the rent rises or falls three shillings per acre. Such is the usual sliding up and down, backwards and forwards, of all the schemes referred to, which are evidently based on no principle whatever; are as imaginary as any scheme can be; and are inapplicable, as a general rule, even to the circumstances of the most limited districts.

5313. The old rule of dividing the produce of a farm gave one-third to the landlord, one-third to the labourers, and one-third to the farmer; but it is now well understood that the tenant does not receive as much of the produce as the landlord does, nor so much as the labourers and other costs demand. While the profit of the tenant has diminished, the rent to the landlord has increased, and so have the costs of management. The tenant has been most liberal to the land in bestowing increasing labour and manure upon it, whereby its fertility and productiveness have been very much promoted, and the landlord has thereby profited largely by a rise of rent. To this liberal spirit of the tenantry is to be ascribed the high state of cultivation which the land in Scotland generally exhibits.

5314. I think that the county average, or Fiars prices of grain, as estimated at present in Scotland, give only a rude approximation to the real average of the entire sales in the county for the season, which arises chiefly from the circumstance that about one-half of the grain remains unsold at the period, February and March, when the averages are taken. Should any unforeseen change take place thereafter in the prospects of the succeeding crop, it is evident that the latter half of the grain may be sold at a very different price from the previous half. Even in districts where the rents are not regulated by the value of grain, and where consequently no desire can exist to depreciate its value, the grain thrashed in spring and summer is of better quality than that thrashed in the early part of the winter, and farmers generally sell their lightest and least valuable grain in the early part of the season. It is well known that wheat only becomes fit for grinding by itself after March, and thence realises a higher price; and although it shrinks much in the stack after that period, it does not so more than it would have shrunk in the granary, and being sweeter

* *Quarterly Journal of Agriculture*, vol. viii. p. 545.

and fresher from the stack, it is worth more money in summer from it than from the granary.

5315. Although a more just striking of the fiars could be easily devised, it would be unjust to alter the mode entirely, until all the existing agreements, which depend upon the fiars prices, had come to an end in the course of time. Until that period arrived, it would be incumbent to continue the striking of the fiars as at present, while, at the same time, another strike should take place at the end of the season, when it might reasonably be concluded that all the grain of the preceding crop had been disposed of. The average of the two strikes should regulate the terms of new agreements; and after it was understood that all the old agreements had terminated, the fiars ought then to be struck at such a season as would embrace the sales of all the corn of the preceding year and crop. Many years ago the fiars were struck both at Candlemas and Lammas. It may be insisted on that the proposed change would operate more in favour of the landlord than the tenant; I would say, be it so, if justice is thereby better dispensed.

ON THE MODE OF OFFERING FOR A FARM.

5316. The common practice for the candidates of a farm is, to present to the landlord or his agent a written offer of the rent willing to be paid by them; and should the farm be complete in its appointments, no conditions are specified; but should any of them be incomplete, the offer is generally accompanied with such conditions, as shall either cause the landlord to complete them, or shall fix the rent in accordance with the actual state of the farm.

5317. That any conditions accompany an offer arises entirely from the state of the farm. Where the buildings and fences are in good order, no conditions in an offer are requisite. But as farms are generally presented in the market—with the house in bad repair, or the steading inadequate or incommodious, or the fences incomplete or in a state of disrepair—conditions become imperative. Too many proprietors seem to think that a farm may be sent to market in any state, and yet expect such a rent as if all its appointments were in the best order. It is evident, however, that no proprietor has reasonable grounds for expecting a rack-rent for a farm in an incomplete state. If he will spare his own pocket in completing the buildings and fences, it is but right

that his rental should be as much diminished as amounts to the interest of the money required to put the farm in order. It is true that he has a perfect right to present his farms to the market in any state he pleases; and it is also true, that tenants will be found to take farms in every state of deterioration; but in such circumstances, no lease can present the slightest guarantee for the regular payment of rent, or for the respectability of the tenant. It were to be desired that every proprietor would put his farms into proper order, as regards the buildings and fences, before offering them to be let. Such a course would redound to his advantage; for a complete farm will command a higher proportional rent than an incomplete one, and it will enable the tenant the better to pay the higher rent.

5318. The conditions may affect many subjects; but those which are indispensable are, when the farm-house requires extensive repairs or additions to render it suitable for the wants of the farm; when the steading requires additional accommodation in conformity with the size of the farm; when the fences require completing, or renewing, or extensive repairs; and when the farm-roads require to be put into a serviceable state. These are all subjects which it is the immediate duty of the landlord to put to rights. If the offer has been estimated irrespective of these particulars, it is but right that the tenant pay the landlord, over and above his offered rent, the legal interest on the sum required to put them right; but when the rent has been estimated on the condition of a complete farm, the tenant ought not to pay any interest on the sum required to put the farm in the completed state.

5319. Other conditions may also be requisite which are not indispensable, such as the thorough drainage of the farm; the formation of a large drain or outlet for the drainage, where such is necessary; the improvement of waste land; the substitution of one sort of power to the thrashing-machine for another, as steam or water for horse-power, when suitable buildings are required for the change. These all constitute permanent improvements in the farm, and belong rather to the landlord

than for the tenant to undertake; but the tenant may be willing to undertake the larger proportion of them, on receiving the landlord's consent,—and if he can secure the landlord's assistance also, he should endeavour to obtain it. When the tenant has abundance of capital to stock the farm desired, and to pay for such improvements, it is well for the farm and for its proprietor; but when such operations would cripple the means of the tenant to undertake, the landlord ought not to consent to his accomplishing them alone, to the detriment of the otherwise good management of the farm: he should rather assist him, by advancing or procuring money, and cause him to pay a little more than the bare legal interest for it. Such a course of proceeding would not only secure the improvement of the farm by a zealous tenant, but would reserve his capital so as to enable him to put the land in the highest state of fertility, by the purchase of lime and extraneous enriching manures. The draining and the improvement of the waste land would soon repay themselves, while the expense of the erection for the change of power would also be repaid the tenant, by the saving in the wear and tear of horses and harness.

5320. Offers are thus received by the proprietor from any number of candidates that may choose to offer for the farm. When all the candidates are on an equal footing, as to the amount of rent offered, and as to respectability of character, the one who specifies the fewest conditions on the proprietor to render the farm complete, is accepted as tenant. It is not probable that all the candidates, or any two of them, are equal in capital, skill, and respectability; but, generally, the one who is willing to take the farm as it stands, and offers the highest, or about the highest rent, is sure of being accepted, and all conditions are as much avoided as possible, as if it is not the business of the proprietor to put his farm into complete order. The accepted offer is intimated to the successful candidate by letter from the proprietor or his agent.

5321. This I think a favourable opportunity for making a few pertinent remarks on the mode usually chosen by proprietors to present their farms to mar-

ket. When a farm is ready for a new tenant, the circumstance is advertised in the newspapers. To this proceeding there can be no objection, since no better mode exists of giving publicity to the fact. In the same advertisement it is announced that offers for the farm will be received until a certain day, which is objectionable, inasmuch as it puts the farm up to *private* auction — one candidate being pitted against another in the dark. In a *public* auction, all the competitors hear the bid- dings announced as they are made, and bid accordingly; and, at all events, the successful competitor only pays for the article competed for a very little above his rival. In the private auction for a farm, no candidate knows the offers made by the others, nor whether any or what conditions are annexed to them, nor how much the accepted offer is above the next highest. Of the two modes of auction, the private one is the less satisfactory to the candidates, because they are purposely kept in the dark and in suspense, and the unsuccessful ones have generally no intimation sent them of the issue of the concealed contest. During the period of concealment the most unfair influences may have been exercised in favour of a particular candidate; and such a one, if possessing capital and skill, may have been induced to raise his offer to the pitch of some adventurer, who will offer any amount of rent to secure the possession of a farm. In accepting of money offers, proprietors virtually yield the valuing of their properties to other parties — implying that they are themselves incompetent to value their own land: that a stranger from a distance, who knows nothing of the soil of the district, of its farming, its peculiarities, is more competent to estimate the value of his land than himself and his friends, who have lived upon it all their days. It is grievous to see proprietors thus acting as if they did not know what to do with their properties; and such a predicament doubtless arises from the evil which I formerly pointed out, of proprietors generally neglecting to make themselves acquainted with their profession at an early period of life, (543.) In every other profession, the disposer of goods puts a value upon them, and when he finds he cannot procure a purchaser at the price he had fixed, he lowers it to suit

the public demand and opinion; but he never demeans himself by asking his customers what they will give for his goods. Such a custom the country chapman only is in the habit of following.

5322. By far the most dignified course for a landed proprietor to pursue, is to put a rent on the farm, which he is sure any industrious and skilful tenant could pay, and fix such conditions of lease as will protect the farm from the effects of avarice, while affording ample liberty to the skill and judgment of the tenant, and then invite farmers to become candidates, not as valuers of land, but as capitalists who can stock the farm, and as farmers who can manage land skilfully; and, from such who have offered themselves, select the one who has the most capital, the best skill, and the greatest respectability. Were such a system generally adopted, instead of the prevailing auctioneering one, I am persuaded that better farming would prevail, a more generally diffused respectable tenantry established, rents more easily and surely paid, labourers more steadily employed, and a better understanding and greater cordiality exist between landlord and tenant.

ON NEGOTIATING THE COVENANTS OF THE LEASE.

5323. On large properties, the terms of lease are usually printed, and a copy is given to every one who chooses to apply for it, when looking at a farm. Should any of the terms be deemed objectionable, they are commented on when the offer is given in, and the alterations desired indicated. On small properties, the conditions are obtained verbally or in writing from the proprietor or his agent.

5324. In any printed conditions I have seen, the covenants are much too strict upon tenants, as much so as if they must be rogues. Precautions are no doubt requisite between strangers—for candidates for farms will be found as unprincipled as to offer any amount of rent, and accept any conditions of lease, to get possession of a farm that is in good order; and, when they have gained possession of such vantage-ground, give incessant trouble to their

landlord. Such a collision might have been avoided by previous inquiry into the character of the candidates, or by following the course of letting a farm recommended above in (5322,) but not by the strictest conditions, without inquiry, that could be imposed. When such an event happens, the proprietor is more desirous of obtaining an inordinate rent than a respectable tenant; and if he thereby finds himself in difficulties, he has himself or his agents alone to blame. Honest tenants require no conditions; but, as the world is constituted, it is necessary to insert restrictions in all bargains about farms extending over a series of years. Such conditions as are actually concocted by legal advisers are minutely harassing to the tenant, simply because they are inapplicable to the character of the particular farm; and wherever a set of conditions are kept stereotyped for the farms of an entire estate, and have been drawn up by persons unacquainted with farming, they are certain of being inept. Each farm ought to have conditions suited to itself; and although they may be rather restrictive, a good farmer will not be long in concluding a bargain, knowing that suitably restrictive conditions, like good penal laws, are only applicable to offenders.

5325. The conditions of a lease may be soon adjusted, if both parties are desirous of meeting on fair terms, or in terms of conditions previously understood between the parties. But in many cases, after the rent has been accepted, on the understanding that the conditions exhibited were unobjectionable, the candidate endeavours to negotiate for other conditions, which will serve, in his estimation, to mitigate the rent he has offered, and which he feels conscious the farm cannot pay. Allowances for draining are stipulated for, and is a proper subject for negotiation at first, when the farm requires it. The steading requires more extensive repairs than the outgoing tenant is bound to uphold; and even additions and alterations are suggested, such as the removal of the horse-course, and the erection of a boiler-house and chimney-stalk of a steam-engine for the thrashing-mill, or the construction of a dam for a water-wheel. A new set of feeding hammels are required, or the courts fitted up with turnip-troughs for

young cattle, or rain-spouts put round the eaves. Though the outgoing tenant is bound to leave the fences in tenantable repair, a new fence may be wanted to run across a field to make it smaller, or along the side of a wood, or public road. A farm-road is required for access to certain fields, which cannot be reached but by trespassing through other fields. An embankment is required along the side of a rivulet which occasionally overflows its banks, and damages the crops of a haugh, or the lower parts of several fields. Proper watering-pools are required in some of the fields. All these are improvements of a permanent character, and ought to be undertaken by the landlord; but they should have been stipulated for in the offer, and not afterwards. When demanded afterwards and acceded to, injustice is done to the other offerers. Had they, when they gave in their offer, understood these were to be conceded, they would all have been placed on the same footing; but it is scarcely fair towards them to make so large concessions afterwards to one party, since the others might probably have offered more largely, had they had reason to believe that propositions, which involved the outlay of so much money, would have been favourably received by the landlord.

5326. It is customary, in leases, for the landlord to reserve for himself the right of opening quarries or mines, of making roads, of entering into woods through fields, and of doing anything on the farm that would benefit the estate, with the proviso of giving damage to the tenant where his crop or the land is injured.

5327. Reservation is also made for hunting and shooting game for the landlord and his friends. The question of game has hitherto caused many heart-burnings between landlord and tenant; much of which, I am persuaded, has originated in the severe restrictions imposed on the tenants against killing game on their farms, who know that the crops they raise feed the game, and yet are debarred from sporting amongst them. I am sure that tenants are desirous to witness the sports of the field, and gratified in seeing their landlord and his friends partaking of them in a manly way. But they naturally feel displeased at seeing their

crops injured at all seasons by an inordinate quantity of game, protected for no apparent purpose than to afford an un-sportsmanlike *battue* once or twice in a year. Let the landlord, after all, enjoy sport as he pleases; but if he delights in breeding large quantities of game, let him confine them and feed them within his own domain; and should any wander beyond it to feed, let him compensate his tenants who maintain them. I have long been of opinion that tenants would make the best protectors of game, were they allowed to take a shot. The indulgence is not great, as they cannot enjoy it without taking out a license, and keeping a dog and paying duty for it—taxes which many farmers will not pay for the sake of sport; but were the privilege generally granted—not as a right, but on the ground of good feeling—the game might devour as much corn and turnips as they please, without a complaint being uttered by the tenants, whether they be sportsmen or not, (4703) and (4706.) Tenants who grudged to pay for a game-certificate and the duty on sporting dogs, would have themselves to blame if they were not sportsmen; but they would take good care that no poachers came near them. Within these two years, hares are placed on the same footing as rabbits, and may be shot without a license.

5328. The periods at which the rent is paid are specifically mentioned in the lease. The most favourable terms for the tenant are Candlemas and Lammas—February and August. By Candlemas, the farmer has had time to dispose of a great part of his corn; and by Lammas he has sold off his fat cattle, sheep, and wool. Both these terms being intermediate between Whitsunday and Martinmas—May and November—when the half-year's wages of the farm-servants, field-workers, and labourers, become due, he escapes too many large demands at any one term. In England, rents are paid at Lady-day and Michaelmas—April and October.

5329. One of the principal clauses of a lease is that which relates to the cropping of the farm. It is customary to bind the tenant to follow a particular rotation of cropping. Such a restriction is inimical to the tenant's interests, and may even prove detrimental to the farm itself.

For example: should a crop fail, such as of clover or turnips, in the early part of the season, the tenant would not be at liberty to plough those fields, and try another kind of crop; and as the ground that should have been covered by a crop becomes a receptacle for weeds, the interest of the farm suffers by such a restriction, while the farmer cannot avail himself of a better mode of cultivation. Restrictions were necessary at a time when mis-cropping was the practice of the day, and they are still necessary in all cases where farmers are so unreasonable as to take advantage of the land. All restrictions necessarily imply that the farmer cannot manage the land properly, and requires a disciplinarian in the lease to keep him right. It is possible, however, to impose such a single restriction as to preclude the possibility of advantage being taken of the land, while it shall not interfere with the free agency of the farmer; and it is this—that no two grain crops shall follow each other—the land growing grain and green crops alternately. With this restriction, it is impossible to injure the land, provided the fallow-crops are adequately manured; and although it is as easy to neglect manuring those crops under the least as the most severe restriction, the salutary check, that green crops will not grow without manure, is always in force against the tenant. By such a clause, the tenant is not bound to follow any system of rotation; but as he must take a green crop between two corn ones, he cannot possibly follow a severer rotation than have half the land in corn; and he will soon find that he cannot sustain the land in heart with that proportion of corn, without purchasing extraneous manure, and that if he does not keep the land in heart, the means of paying his rent will rapidly decline. Towards the latter end of the lease, it is probable that the tenant may take advantage of the land, by declining to purchase extraneous manure, especially if he wishes to quit the farm. To meet such an exigency, it becomes necessary to impose severer demands upon him on the subject of manuring; and moreover, still without insisting upon any particular rotation, it will be sufficient to stipulate that not less than a given proportion of the farm shall be left in grass, laid down with a grain crop, after a manured fallow one. When-

ever the tenant chooses to leave more grass, so much the better for the landlord and the land.

5330. I do not know why it is that leases run for the particular term of 19 years, as that period corresponds with none of the rotations in existence. I think it desirable for the farm, that the fields be left under the same or similar crops they were entered to; and to secure this end, the lease should endure such a number of years as would be those of the rotation which best suits the soil, multiplied by a given number of rotations. For example: A farm in the neighbourhood of a town where the four-course shift is practised, should have a lease of 16 or 20 years, the rotation having been *four or five* times repeated; a farm of mixed husbandry under the five-course shift, one of 20 or 25 years, and under a six-course shift, one of 18 or 24 years; and for an eight-course shift, such as a carse clay farm, 16 or 24 years. The advantage of such an arrangement would be, that as the same fields would be in the same or similar crop at the end of the lease as at the commencement, an easier comparison could be made whether or not the farm were in better or worse condition at the end of this lease than at that of the former; a result which would enable the landlord to determine whether the land would be improved under a different course of cropping, or only under more skilful management. In the latter case, a better tenant would be an acquisition to the estate, whilst in the former, a change of rotation would effect the improvement with the same tenant.

5331. The conditions of lease are generally the same for all the arable farms of an estate, except a particular farm should contain strong clay soil; but, to be really beneficial to soils, it is clear that all conditions should be made suitable to the circumstances of the individual farm. I am convinced that inattention to this matter causes many a farm to be ill-farmed, and disappointment and loss of capital to many a good farmer. A weak soil cannot endure the cropping of a strong one, nor a deaf soil support stock like a sharp one; each class of soils requires different treatment—why, then, should all be placed under the same conditions? Simi-

larity of conditions is a simple mode of placing all the farms of an estate under one class; but its adoption displays no judgment, and evinces want of discrimination on the part of its owner. No stronger example than this can be adduced for the propriety of allowing a good farmer to exercise his skill according to the nature of the soil; and where the exercise of judgment is granted, the farm improves, and the tenant prospers. But such a liberty cannot be granted to one tenant without extending it to all, is the narrow view taken of the subject; so that the skill of a superior tenant is purposely cramped, for the sake of maintaining a check upon an unskilful one. Much better, let it be obviously known, that the skilful tenant is purposely encouraged, and the slovenly one kept under restrictions, than follow such a depreciatory system. The good that would arise of discriminating the capabilities of farms, and also the propriety of choosing the tenant and not the rent, is thus clearly made apparent.

5332. There being no rotation of cropping on a pastoral farm, except on the small portion of ground available to culture, the number of years of the lease may be left indefinite; but should the farm retain its stock, whether of cattle or sheep, until they are two or three years old, the principle for calculating the duration of the lease might be the multiple of those periods; but usually pastoral farms have not so long leases as arable, there being a mutual desire between landlords and tenants to adjust rents according to the prices of stock and wool every 7 to 14 years.

5333. Other clauses, in regard to cropping, besides those relating to rotations and general management, such as classing flax among the corn-crops, are sometimes introduced into leases; as also in regard to manuring. Half manuring on the oat-stubble in autumn, or in the drills in spring, will suffice for pease and beans; but it is too much exertion for any land, even in the highest heart, to produce a crop of oats, then of beans, and then of wheat, without manure. Potatoes are sometimes prohibited being sold off a farm, unless dung be brought in return, as they leave no refuse for manure; but being

human food, profitable to the tenant, and raised necessarily on manured soil, I do not perceive the justice of this restriction. The hay crop is more injurious to land than potatoes, and yet it is usually permitted to be sold. I expect to see the day when no hay shall generally be made upon a farm, unless it be from grass in a succulent state, and from permanent meadow, and to no greater extent than to supply its wants, which are not great when cooked food is easily made. In the neighbourhood of towns, where manure can be obtained at will, the sale of hay and even straw to their inhabitants is permitted; but straw is generally prohibited being sold, as also farmyard manure.

5334. Penal clauses are inserted into every lease, and seem necessary for the protection of the landlord. In cases of miscropping, by taking two corn crops in succession, a penalty of £5, or £10 an acre, over and above the rent, is threatened; and a large fine is required for this purpose, otherwise the advantage gained by miscropping would be very considerable. An obligation is made imperative upon the tenant to remove from his farm at the time specified in the lease, without the exhibition of the usual legal instruments of dismissal; otherwise the ejection of a tenant reluctant to leave his farm might be attended with much trouble and considerable expense. The subletting of a lease to another party is prevented, as well as its assignation to trustees for behoof of creditors; and when either is permitted, it is by consent of the landlord—which are proper restrictions, otherwise the farm might be alienated from the proprietor for the whole course of a lease, for the benefit of parties with whom he has no concern.

5335. In Ireland, leases are frequently granted for a long series of years—from 21 to 31 years—accompanied most commonly with a life time of some young prince or nobleman, or of three persons mentioned in succession, as they happen to die. It is probably owing to this long alienation of his property by the proprietor, that the feeling of proprietorship so strongly exists in the minds of the Irish tenants.

5336. The subletting of farms is gene-

rally permitted in the leases of Ireland ; and such a permission seems almost necessary when long leases are granted, and when it may be inconvenient, in their course, for the successors of the deceased tenants to retain them with advantage to themselves. A worse species of subletting than this exists when the proprietor sublets the whole or a part of his rental to a middleman, who, to procure the largest profit to himself, lets small holdings to poor tenants at exorbitant rents, or lets fields from year to year, at still higher rents, on what is called the con-acre system. Fortunately for the tenants and the country, the manifold evils of this system have given rise to a desire for its abandonment.

5337. The subdividing of farms was long permitted in the Irish leases, and its effects were worse even than subletting, inasmuch as its tendency is to fill a property with poor tenants, possessing as little skill as capital. To obviate the evil consequences of the system, those proprietors who have to support their tenants on the poor-roll are impelled to eject them in numbers ; otherwise, they would retain possession of the land, and pay no rent. Time alone will be able to counteract the effects of so objectionable a system as the subdivision and the subletting of land.

5338. In the north of England leases are common, and upon conditions pretty similar to those in Scotland. In the midland and southern counties leases are the exception, and tenancy-at-will the rule. A strong aversion exists in Scotland against tenancy-at-will ; but, from the manner in which it has worked in England, it cannot be so unmitigated an evil as represented. Families of farmers have sojourned upon the same farms for generations, and have become in the end independent yeomen. Any system that produces such effects cannot be essentially bad ; and bad it has certainly not been for the tenant's interests, otherwise they would have endeavoured, long ere this, to have got rid of it ; and I question much that if the alternative of their present condition, and that of a lease were placed before them, the majority of the farmers of England would wish for a change. The question is, would they have been happier,

more wealthy, more respectable, as a class, under a leasehold tenure, than under that of tenancy-at-will ? The question will not be answered by a mere reference to the condition of Scotland under the lease. Scottish agriculture has prospered under the lease, probably because the tenants, true to their national character of trusting implicitly in no one, would not confide in their landlords ; and the Scottish landlord has no doubt also acted on the same principle. Where two suspecting parties meet, nothing but a strict agreement will answer their purpose. The lease guarantees possession for a given number of years ; and insures a certain amount of returns, at least for the capital expended in the skilful and liberal treatment of the soil. English agriculture has, perhaps, not prospered so well ; because the English tenant, acting in the spirit of the national character, has much confidence in the implied faith of his landlord's family, in return for which the landlord demands a rent in a similar spirit ; and the consequences have been all in favour of the tenant—for, if the land has not been so well farmed, the tenant has been the more enriched. Although I am sure that the lease is indispensable in Scotland and Ireland, I am not sure that it would produce similar effects in England. However this may be, let the parties most interested discuss the question between themselves.

5339. The lease is not without its alloy. It binds the family of a deceased tenant to the farm, when it might be for their interest to give it up and divide their patrimony. It may prove injurious to an unfortunate tenant, who cannot appoint a trustee over it to wind up his affairs in the most economical way. It renders the position of the tenant unpleasant, when it binds him to a rent fixed in conformity with prices much above what he is likely to receive in the future. It causes a sudden rise of rent at the termination of an improvable lease. It tempts an injudicious tenant to expend more of his money upon the improvement of land, than it affords him time to receive it all back again.

5340. Although a tenancy-at-will avoids all these inconveniencies, a lease is of benefit to the tenant, by insuring

him a certain home for a given number of years—by affording him, most probably, as much time as to receive back what he may have expended upon the land—by securing to him the fruits of his enterprise for a given time; but as to the political independence said to be afforded by the lease, I am doubtful that a tenant in Scotland is any more of a free agent than a tenant in England.

5341. In reference to the application of the grain rent to a tenancy-at-will, I would again quote from the writer to whose opinions on this subject I have already made so many references. "What we wish to point out is," he observes, "that the injustice of fixed rents is most generally felt in cases of farms let on lease, and this, in our opinion, forms the only strong argument against leases; and therefore the establishment of a proper system of fluctuating rents would, besides its other advantages, be the most effectual way of extending throughout England this tenure, which, even on a less perfect system, has been of immense advantage to the agriculture of Scotland. We do not, however, mean to say that it would be useless to adopt such a system in cases of tenancy-at-will. The rents in such a case are often allowed to remain, nominally at least, unchanged for generations, so that they become as ill suited to the times as those of tenants on lease. The loss, however, from fixed money-rents at will is chiefly felt by proprietors when rents are naturally rising; for they, being felt generally as a harsh measure, do not raise the rents of respectable tenants, however justly they are entitled to do it. On the other hand, when rents are naturally falling, tenants-at-will get reductions, though their rents may be nominally continued at the original amount. Tenants-at-will, therefore, need not suffer heavy pecuniary loss from a fixed rent, as they have always the alternative of quitting their bargains should there be no reduction. In such circumstances, however, tenants are in an ignominious state of dependence on the generosity of their landlords, and these, on withholding the customary and necessary reduction, have a ready means of getting quit of tenants. It thus appears that a

proper system of fluctuating rents would practically be as useful in cases of tenancy-at-will as on lease. Such a system seems, however, in a theoretical view, to be most required on leases; and its establishment would therefore, we think, remove the most plausible argument against that practice."*

5342. Many trifling conditions still exist in leases, indicative of the spirit of feudalism—one of which is the payment of *kain* or *cane* fowls. If the landlord desires to have the fowls for domestic use, he will have a much better choice of good poultry, of all ages and kinds, amongst those who have poultry for sale, than in *kain* fowls. From the general dislike to deliver *kain*, the fowls are frequently delivered old and lean, and when objected to, the shame of detection, followed by worse feelings, is felt by the tenant ever after. It would be well to abolish the paltry impost altogether.

5343. Personal services, such as driving coals for the landlord's use, are still imposed in leases. Such a service is convenient for a landlord who has no work-horses of his own, and is regarded as trivial by the tenants, if demanded at a time when field-labour is not urgent. Such a service, nevertheless, ought to be convertible into money at the option of the tenant, rather than of the landlord.

5344. In Scotland, the public burdens on land are paid by the proprietor, and the tenant has nothing to pay but his stipulated rent. In England, all the public burdens are paid by the tenants. Of the two methods, the Scottish is much the fairest for both parties, it being no more than reasonable that the proprietor should pay the burdens of his own land; and it is certainly unreasonable to make the tenant pay those burdens, when he has no voice in the affairs of the county. It is true that the amount of the burdens is taken into account in determining the rent at the commencement of the lease; but as they vary considerably, and are always on the increase, it is not possible to know what their amount will become by the termination of the lease. If the burdens

* *Journal of Agriculture*, January 1846, p. 139.

are paid by the tenant on stipulation, he does so merely for the convenience of the landlord, who deducts the payments from the rent.

5345. But some of the public burdens are paid by the tenant as such. He gives the labour of his men and horses, for a given time, upon the statute-labour roads through the property, or commutes it by payment in money; and he pays his share of the poor-rates, which is now considerable in Scotland, is very onerous in Ireland, and but little abated in England.

5346. Of late years the claim of "tenant right" has been agitated both in England and Ireland, and should the subject be settled in any form by the legislature, it must enter as an element in the negotiation of the covenants of a lease. Taking a general view of the subject, according to my notion, in regard to any "right" connected with land, it must be conferred by statute, or by special contract betwixt the owner and the cultivator of the soil. Until, therefore, an Act be passed conferring it, or an agreement be entered into by landlord and tenant, no "right" can exist in my opinion. It will be time to talk of a "right" after it has been conferred, but the attempt is made to have the "right" conferred. Let us therefore see what the "right" is which is demanded, and whether or not it be reasonable in itself.

5347. I understand that the right claimed in England for a statute is that, whenever the tenant shall have laid out money upon his landlord's land, which has obviously improved it, he shall have the "right" to make his landlord reimburse him the amount when he leaves the farm. For example, if he shall lay out money in erecting buildings, forming fences, making farm-roads, draining, liming, manuring, and so forth, he shall be reimbursed for one and all of these outlays when he leaves the farm, or when he dies. The claim does not in its terms seem unreasonable, but the obvious question arises, whence came it that he incurred these outlays? Did he lay out all that sum of money upon another's land, without his consent being asked and granted? If the consent were asked and granted, then the landlord tacitly became

responsible for the outlay; and the tenant, when he made the request, would no doubt intimate to him that he looked to him for repayment. But if he laid out the money without asking his landlord's consent, is it reasonable, is it common-sense, is it justice, that the landlord shall be *obliged* to reimburse money in the outlay of which he had no voice? Would such an obligation not be tantamount to making the landlord lay out money in improving land whether he willed it or not, or whether he was able or not, and to lay it out, too, in a manner not to please himself, but to please another party? No legislature would confer such a "right," which would amount to tyranny. When a tenant leaves a farm in better state than he got it, the landlord will receive a higher rent for it from the new tenant. Whether the outgoing tenant has a claim for compensation, in such a case, depends upon circumstances. If the tenant paid as much rent for the land it was fully worth at the commencement of his lease, and no rise of prices had taken place during it, I should say that the landlord is obligated to him, and should make him some compensation for his liberality to the land; but if he got the farm at a low rent, according to the terms of an improving lease, and prices had risen in the interval, then I say he has no claim for compensation. He has enjoyed the possession of rent less than the rack-rent, and the rise in price, which would of itself have raised the rent during his entire lease. Where the tenant has voluntarily undertaken buildings, fencing and draining, even by his landlord's consent, that landlord would be unreasonable who would refuse him all compensation. But all these matters ought to have been settled in the lease, and it is only within the covenants of that document that the "right" of the tenant should be found. The claim of "right" is specially put forth for the tenant-at-will, in order to induce him to improve his farm; but such an expedient is but a poor substitute for the security conferred by a lease. The struggle, therefore, should be for the lease, and not for the "tenant right."

5348. The "tenant right" claimed in Ireland is of a different nature, its pretension being of an extravagant character, and if granted would virtually render the

tenant the proprietor of the soil. I have seen the claim put in these terms:—"The advocates of 'tenant right' claim liberty to sell their possession to the highest bidder. They state that by the erection of buildings, draining, and other improvements, they have expended their capital on the land, which they have a right to be repaid; or, if they have not done these things themselves, they have paid to their predecessors in the occupancy of these farms a sum of money for possession, including the improvements which the former occupier may have made: and for this they expect compensation. They demand, not only compensation for any improvements which they make, but also for those which have been made either by themselves or their predecessors, and they require the legislature, in any act which may be passed, to provide security for both. This renders the question both difficult and complicated, and the difficulty is still more increased by the fact that, at the present rent of land, the mere 'tenant right' which the parties in possession believe they have acquired, either by the improvements which they have made, or for which they have given compensation to their predecessors, would produce nothing, and that in many cases the possession of the farms would not be accepted even as a free gift." The relation of landlord to tenant in Ireland is by no means in a satisfactory state, but it is not by such claims as these that it will ever be amended. In Ireland, the tenant is too apt to get into the notion that he is all but proprietor of the ground he occupies, and to act accordingly.

5349. "A minute of lease, like missive letters, must be stamped before action will lie, and it is recommended that, before possession, a formal lease shall be executed."*

5350. "Where the return in kind made by the tenant was meant to be consumed in the household of the landlord, it consisted not only of grain, but of other produce. This return was called *cana* or *kain*, which has been deemed to signify merely a certain annual presentation. In more ancient leases, fed cattle were payable. Custom wethers and fowls are specified in the style of the tack given by Dallas. In some leases, comparatively modern, there is a stipula-

tion for the delivery of *kain* fowls, which are also called flying customs. In some districts, a customary payment in produce is made by the lessees of fisheries; and in the more remote parts of Scotland, it is understood that there still exist customary returns in produce of various kinds, which, being regulated by the usage of the district, or of the barony or estate, cannot be comprehended by any general rule. When treating of rents in question with regular successors, it was recommended that such returns should be made convertible into money at the option of the lessor, and the lessee ought to have the same power."†

ON ENTERING TO A FARM.

5351. The usual period of entry to a farm in Scotland is at Whitsunday and Martinmas, or at the separation of the crop from the ground. These terms of entry are not equally favourable for the tenant in every species of farming. Entry to the houses and grass at Whitsunday is convenient for a tenant practising mixed husbandry, as it enables him to sow turnips for his stock in winter, and to fallow land for autumn wheat. Were he to enter wholly at the separation of the crop from the ground, he would have no turnips for his stock but what he purchased, either from the way-going crop on the farm or elsewhere. Entire entry cannot be given to any incoming tenant at Whitsunday, as he cannot enter the ground on which the way-going crop is growing. The second entry at Martinmas enables the in-comer to plough the stubble land in time for the ensuing green crops.

5352. Entire entry at the separation of the crop from the ground, is convenient enough for the tenant who breeds no live stock, as he can purchase them for winter, according to the opportunity afforded him to purchase straw for litter and turnips for food, either from the way-going crop on the farm or elsewhere. The carse farmer, and the one in the neighbourhood of towus, would also find this a convenient enough term of entry.

5353. A dairy farmer finds it most convenient to enter at Whitsunday, having the grass in summer, and the power to

* *Farmers' Lawyer*, Appendix, p. 223 to 331.

† *Hunter's Law of Landlord and Tenant*, p. 634-5; and p. 835-9.

raise turnips for winter; and so does the pastoral farmer, whether of cattle or sheep.

5354. The most generally convenient times of entry, for all sorts of farmers, is that to the houses and grass at Whitsunday, and to the land at the separation of the crop from the ground.

5355. In England the times of entry vary much in the different counties. Perhaps the most common entry is at Old Lady-Day to the houses and grass, and to the land at Michaelmas; but entry is also given as soon as Candlemas in some districts.

5356. In some leases, the out-going tenant at Whitsunday is prohibited grazing the new grass in the spring, which is a good stipulation for the in-comer, as it is quite possible for the out-goer to eat the new grass so bare with his stock, by Whitsunday, as to deprive the in-comer the use of it for several weeks after that term.

5357. The out-going tenant has always a way-going crop, which he can dispose of in two ways—one when he must leave the straw in *steelbow*, the other when he can dispose of the entire crop as it grows. “By a declaration that the straw and manure are *steelbow*, it is assumed that they are given by the landlord, and are to be returned to him; or, what is equivalent, delivered to the in-coming tenant, to whom the landlord has conveyed his right to them. A sufficiency of manure, and of the materials for its formation, are thus permanently retained on the farm.”*

5358. The *steelbow* is a great boon to the in-coming tenant, it being equivalent to his possessing as much more capital, at the entry to his farm, as the straw and dung he receives are worth in money—for, without them, he would have to purchase both somewhere.

5359. When the way-going crop is disposed of by public sale as it grows, the sale takes place a few days before the crop should be cut down; and for the convenience of purchasers, the fields are divided into lots comprehending two or more ridges, according to their length, the lot

not containing more than five acres. As oats and oat-straw are the most convenient sort of crop to purchase, the way-going crop consists as much of that species of grain as practicable. It is obvious that the in-coming tenant has no more chance of securing a part or whole of the crop, than any other person; and should it fetch higher prices than he is disposed to give, he will rather purchase straw elsewhere; but, in any case, he is obliged to purchase corn he may have no use for, in order to secure the straw upon which it grows, and of which he is at the time much in want. The practical effect of this system upon the in-coming tenant is, that he must possess capital to purchase as much straw as his stock will require in winter, and as much manure as will do justice to the land in summer; and its effect upon the farm is, that, should the in-coming tenant not have capital beyond the stocking of the farm, he cannot purchase a sufficient quantity of straw and manure, and both his stock and his land must suffer privation to that extent. It is true he can bring his own way-going crop, if he be leaving one farm to go to another, to the new farm; but unless the two farms are near, it would be impracticable to carry a crop, and build it in the stackyard, at a season when everybody is too busy to render him any assistance. In some cases, the lease provides that the out-going tenant is obliged to offer half the crop in valuation to the in-coming tenant, or the landlord—and should either refuse the offer, he is at liberty to sell it; and in other cases, a private agreement is made for the whole crop between the in-coming and out-going tenants, irrespective of the lease. The purchaser bears the expense of cutting down and carrying in the part of the crop he has purchased. In any case, the in-coming tenant is placed in a worse position by this than by *steelbow*, which, in my opinion, is a principle that ought to be generally adopted in reference to straw and dung, except near towns.

5360. In regard to the sum obtained for a crop as it stands, the value of the grain depends on the price likely to be obtained for it in the market in the ensuing winter. The in-coming tenant who

* *Hunter's Law of Landlord and Tenant*, p. 264.

enters as a beginner, will consume most of the oat crop in supporting his men and horses, and in sowing the oat-break of the succeeding crop. The crops are estimated by the acre, and after deducting the expense of reaping, carrying, stacking, and thrashing, the value per acre of the grain is ascertained; and that of the straw is worth so much per quarter of grain per acre. Suppose, for example, that the crop of wheat is estimated at 4 quarters per acre, and is worth 40s. per quarter and the straw 10s. per quarter, the value per acre will stand thus:—

4 qrs. Wheat, at 40s., . . .	£8	0	0
Straw, 10s. per qr., . . .	2	0	0
	£10 0 0		
		s.	d.
Deduct reaping per acre, . . .		10	0
— carrying, — . . .		6	0
— thrashing, 1s. per qr., . . .		4	0
		1 0 0	
Value of the crop per acre, . . .	£9 0 0		

In like manner with other sorts of grain. The value of oat-straw may be taken at 5s. 6d., and of barley-straw 4s. per quarter.

5361. Whenever the way-going crop is sold on its foot, and it has been cut down and removed by the purchasers, the in-coming tenant enters and ploughs the stubble land, and the out-going tenant takes his departure; but when the straw is held in steelbow by the farm, the out-going tenant has a right to be accommodated in the stackyard and the steading until the crop is thrashed and delivered, for which purpose he must have the control of the thrashing-mill, as much of the work-horse stable as will house as many horses as the thrashing-mill requires—and if it be moved by power, as many as will be required to take the grain to market; and as many cottages as should be occupied by one man and at least three women, to take charge of the crop for thrashing and sending to market. The out-going tenant must not thrash his crop faster than the in-coming one can consume the straw with his stock, to save it from waste; nor must the in-coming tenant use the straw more slowly than will allow the out-going one to have cleared the stackyard by the Whitsunday following, when he leaves the

farm entirely by giving up the keys of the corn-barn, and withdrawing his work-people and horses from the houses and stables. Not unfrequently the in-coming tenant undertakes for the out-going one the thrashing and delivering of the crop to market, on payment for the trouble.

5362. There are always questions of minor magnitude, though of importance between the landlord and out-going tenant, the settlement of which are usually made over to the in-coming tenant, as being the party most affected by them. These consist of the state of the fences, of the gates, of the steading, and of the dwelling houses, all which the out-going tenant is bound to leave in tenantable repair. The most pleasant way of ascertaining the fact, whether these are left according to the terms of the lease, is by *arbitration*, undertaken by friends mutually chosen by the out-going and in-coming tenants, with power to the arbiters to appoint an overseer, in case of a difference of opinion arising between them. When the fences and buildings are obviously in a tenantable state of repair, the business is soon settled; but when otherwise, the arbiters appoint tradesmen, acquainted with the respective sorts of works, who are paid to inspect the state of the particulars under arbitration, to calculate the costs of repair, and to report their opinions in writing, or in evidence. The decret of the arbiters containing their awards, results in the out-going tenant paying the expenses of repair to the in-coming, who thus becomes obligated to leave the same articles in a tenantable state for his successor. These are the ordinary subjects of the arbitration; but any other, such as the value of the way-going crop, may also be arbitrated by the same parties.*

5363. The greatest difficulty which the young farmer experiences, on assuming the management of a farm, is in distributing and adjusting labour. To accomplish these correctly, both as regards the work and the labourer, a thorough knowledge is requisite of the quantity of work that can be performed in a given time by all the means of labour, animate and mechanical, usually employed. It is the duty of the young farmer to have acquired this know-

* Parker's Notes on the Law of Arbitration.

ledge with all correctness ; for a skillful *distribution* of the workers enables the work to be performed in the most perfect manner in regard to the soil,—with the smallest exertion as regards physical force,—and with the greatest celerity in regard to time ; and a judicious *adjustment* of workers to one another, places every one in a position to perform his own share of the work and no more, (60,) (66,) and (69.)

5364. There are few things that strike a practical man more forcibly, in comparing the agriculture of England and Scotland, as the distribution of the work-people in the fields. In England, it is not uncommon to see them employed in several fields of a farm at the same time, and the ploughs working scattered here and there. Now, the great principle kept in view in Scotland, as regards the employment of the work-people of a farm, is to concentrate the energies of them all as much as possible. Many operations require the conjoint labour of the teams and field-workers, and when so employed, they are confined within a given space of the same field, that the work may be performed in as short a time as possible ; and it is not possible to accomplish that end unless the labourers, of whatever kind, are so distributed and arranged, that one party shall push on another, and should one individual flag, those who follow are prevented proceeding in their work. When labourers are scattered over different fields, doing different sorts of work, as is too much the case in England, no emulation can arise, and no effectual superintendence can be exercised ; and the consequence is that less work is done, and not so well done. In Ireland the case is still worse, for there no methodical arrangement of the labourers in the fields seems to be attempted, or at all understood.

5365. I have recently seen the following statements by Mr W. Burness of London, of the production and value of each class of labourers in each of the kingdoms of the empire :—

	Arable acres to each labourer.	Pasture.	Total.
England,	13½	17	30½
Scotland,	19½	17½	37½
Ireland,	2½	4	6½
	Arable acres to each ploughman.	Pasture.	Total.
England,	50	74	124
Scotland,	50	44	94
Ireland,	26	41	67
	Arable acres to each common labourer.	Pasture.	Total.
England,	30	40	70
Scotland,	159	142	301
Ireland,	7	10	17
	Arable acres to each boy.	Pasture.	Total.
England,	84	109	193
Scotland,	84	77	161
Ireland,	11	16	27
	Arable acres to each woman.	Pasture.	Total.
England,	311	459	810
Scotland,	186	166	352
Ireland,	11	16	27

* *Journal of Agriculture*, July 1850, p. 450.

	Value of the produce of arable acres to each labourer.	Pasture	Total.
England,	£77 14 9	£61 12 3	£139 7 0
Scotland,	107 3 5	52 18 9	160 2 2
Ireland,	14 0 0	10 0 0	24 0 0
	Labourers.	Wages.	Total value.
England,	1,000,000	£27,508,675	£139,350,000
Scotland,	170,000	4,243,772	27,218,416
Ireland,	2,000,000	15,000,000	48,000,000

"The foregoing tables," observes Mr Burness, "fully bear out the truth that a similarity of practice has not yet been established in the three kingdoms, sufficiently clear to be recognised as a common index to the state of their agricultural industry ; that differences exist, not only at variance with science, but of a character and magnitude affecting the health of the empire—differences, too, not only between the long degraded sister country and England, but also between England and Scotland. Every labourer of Scotland, it will be perceived, returns his employer, from the comparatively poor soil of the north, L.20 annually more than do those of England from her richer soil ; and were the fertility of the soils equal, the difference would be still greater. But, even as it is, such a difference for each labourer is obviously a national shortcoming, which amounts to a sum equivalent to little short of Old England's rent-roll. In Ireland, again, were the whole of her produce divided among her agricultural labourers, allowing nothing for tradesmen's accounts, tithes, rates, and the interest of capital invested by landlord and tenant, it would not advance them to a level with those of England."* It would scarcely seem credible, did the foregoing figures not bear testimony to the fact, that one labourer to 159 acres of arable land produces an annual value of L.107, 3s. 5d., while one labourer to every seven arable acres in Ireland, produces only L.14 of yearly value of produce. No wonder that paupers swarm in Ireland !

5366. In regard to the establishment of *steelbow*, Mr Hunter says that, "the noted statute 1449, c. 17, laid the foundation of an important change upon the condition of the tenantry of Scotland. By it the tenant was secured in possession against purchasers, creditors, and all singular successors of the landlord. But the terms of that statute prove that, at the date of its enactment, the cultivators were in a degraded state. They are called in the statute 'the poor peopel that labouris the grund,' which emphatically conveys the idea of the want of capital and skill. Although there are indications, previous to this period, that the tenantry were in possession of a certain portion of stocking, and of the implements of tillage, yet it is difficult to ascertain the precise nature of the right in them which they were entitled to claim. There is a probability so great as to approach to certainty, that the cultivators were of that class who were afterwards called *steelbow* tenants, which, if now altogether extinct, was practically alive until late in the 18th century. These tenants received from the landlords, upon their entry, implements of husbandry, cattle, and grain, and were bound,

upon the expiration of the lease, to return the same number and quantity in equally good condition. A qualified right of property was thus possessed by them. Cultivation by such means almost always exists in an early age of society, as may be gathered from numerous facts. In Greece, the cultivators were apparently of this class. In Rome, the *coloni partiarum* must be ranked under it. And on the Continent almost any other class was unknown, not only during the middle ages, but in some of the most civilised nations down to a very recent period. In many of the provinces of France and Italy they were, under the name of *metayers*, the sole cultivators, so late as the end of the last century; and the treatises on French law abound with rules for the guidance of the contract. In those Eastern countries where agriculture is considerably advanced, this mode of culture is practised. Traces also exist of its having been known in England, for ancient leases were formerly cited, by which both live stock and grain were thus conveyed to the lessee. In Scotland, a similar state of manners must be presumed to have induced a similar result. But while the technical term *steelbow*—which signifies in the Teutonic, goods placed on a farm or attached to it—establishes the existence of this species of contract, yet there are, in the earlier records, fewer certain notices of it than might have been expected. This probably arose from the fact that, as all the tenants were ranked under this class, the execution of a lease implied that implements, cattle, and seed were to be furnished to the tenant.*

ON THE STOCKING OF A FARM.

5367. Having valued the farm; made up your mind as to the rent it is worth; made offer of the rent, and been accepted; agreed to the conditions of a lease; submitted questions of arbitration between yourself and the outgoing tenant; waited until the period that entry is given to at least a part of the farm; the time has arrived to purchase the requisite stocking. To give the most practical view of stocking a farm, it will be necessary to enumerate the implements of husbandry required to be purchased at successive periods, until entire entry has been fully obtained, and the live stock and corn required at starting, to suit a five-course rotation on a farm of 500 acres. The prices of implements may differ in different places, according as they are purchased at sales, or from an implement maker and manufacturer. I have given the prices of new ones in Edinburgh, and it was necessary to state a price in order to make the statement intelligible.

5368. December 1849.—Supposing that entry to the fallow-break is at Martinmas, and to the grass land and houses at Whitsunday, with the exception of the barns, stackyard, and two cottages, retained by the outgoing tenant, for the convenience of managing the way-going crop, the first expense incurred is the ploughing of the fallow-break, which, if done by hired labour, will cost 8s. per acre, but if done by the goodwill of neighbours in a "ploughing-day," which is the custom of the country, and is regarded as the earnest of a hearty welcome to a stranger, the cost will consist of ale and bread to servants, and a dinner to their masters, say 90 persons at 2s. 6d. each, £11 5 0

5369. March 1850.—Attendance at hiring-markets, for the engagement of farm-servants for one year, from May 26, 1850, with cost of arles, 1 0 0

The men hired should be a steward, shepherd, cattle-man, hedger, 5 ploughmen, and a stout lad to work an odd horse.
Select 11 work-horses, from 4 to 6 years old, at £30 a-piece, 330 0 0
A brood-mare in foal, 30 0 0
A harness-horse, 5 or 6 years old, 25 0 0
6 Sets of work-harness, each to contain the following articles:—

2 Bridles, 2 collars, 2 cart-saddles and breeching, 3 back-bands, 2 pairs of long and 1 pair of short-chains, 2 pairs of cart and 2 pairs of trace-chains, 2 cart and 1 trace belly-band, 2 iron back-bands, 1 leading-chain and belt, 1 pair of cart-ropes, long and short cart and plough reins, 2 nose-bags, at £8 each set, 48 0 0

1 Set of gig-harness, riding-saddle and bridle, and stall-collar, 5 0 0
1 Corn tun for work-horse stable, 3 10 0
1 Corn tun for riding-horse stable, 1 10 0
10 Whole-bodied single-horse carts, at £10, 100 0 0
2 Tilt-carts, at £12, 24 0 0

6 Corn-carts, to mount on single-horse cart-axes, at £3, 10s., 21 0 0
2 Cart-frames, at 30s., 3 0 0
6 Stretchers for trace-horses, at 1s., 6 0 0
6 Iron ploughs, at £4, 4s., 25 4 0
6 Slides for ploughs, at 2s. each, 0 12 0
2 Iron small ploughs, at 50s., 5 0 0
1 Iron double mould-board plough, 3 10 0
2 Iron scufflers, at 50s., 5 0 0
6 Pairs of harrows, with master swing-tree, at 42s., 12 12 0

1 Carriage for harrows, 3 0 0
6 Full sets of swing-trees, at 12s., and an extra one, 4 4 0
3 Long swing-trees, for drilling, at 2s. 6d., 0 7 6
6 Fearing poles, with iron points, at 1s. 3d., 0 7 6

1 Pair of harrows for grass-seeds, 1 7 0
1 Finlayson's rubber, 7 0 0
2 Two-horse rollers, of metal, at £12, 24 0 0
1 Presser roller, 2-wheeled, 6 10 0
1 Wheelbarrow, 1 0 0
1 Broadcast sowing-machine, with 3 wheels, 12 0 0
1 Turnip double-drill sowing-machine, 6 10 0

1 Bone-dust and turnip double-drill sowing machine, 11 10 0
7 Grains for dung, at 3s., 1 1 0
4 Spreading grains, at 2s., 0 8 0
7 Lime shovels, at 4s., 1 8 0
2 Ditching shovels, at 4s. 6d., 0 9 0

3 Ditching spades, at 4s. 6d., 0 13 6
1 Hedge spade, 0 4 6
1 Dutch hoe, 0 2 6
7 Stable forks, at 1s. 6d., 0 10 6
2 Long do., at 2s. 3d., 0 4 6
4 Half-long do., at 1s. 9d., 0 7 0
4 Field and stack forks, at 1s. 9d., 0 7 0

3 Dung-hawks, 1 with 2 prongs, 1 with 3 prongs, and 1 with 4 prongs for cow-bye, at 4s., 0 12 0
2 Mud loes, at 2s. 3d., 0 4 6
1 Metal trough for pigs, with divisions, 1 1 0
1 Hedge-knife, large, 0 7 6
1 Pruning-knife, 0 3 0

Carry forward, £741 8 6

* Hunter's Law of Landlord and Tenant, p. 40.

	Brought forward,	£741	8	6
1 Breasting-knife,			0	5
1 Grindstone,			0	10
1 Axe,			0	3
1 Saw,			0	6
1 Sledge-hammer,			0	6
2 Hand-picks,			0	12
1 Mattock,			0	6
1 Iron foot-pick,			0	8
2 Small stone-hammers,			0	3
1 Iron lever and wedges,			0	15
2 Tar-kits,			0	5
2 Oil-tins,			0	5
7 Cows' bands,			0	7
1 Bull's chain,			0	2
1 Imperial bushel and strike,			0	18
2 Double-quart, or tenth-bushel measures,			0	5
2 Sowing sheets,			0	2
2 Ruskies for carrying seed, at 5s.,			0	10
20 Corn-sacks, at 1s. 6d.,			1	10
2 Stable-pails,			0	9
2 Horse-sheets, 1 at 20s. and 1 at 10s.,			1	10
1 Set of Phlemes, Blood-stick, Clyster-pipe, and Drink-horn,			0	6
1 Pump and trough,			5	0
1 Boring-rod and spirit-level for draining,			1	0
		£757	11	6

5370. April 1850.—The tillage land of 500 acres will be apportioned in this manner:—

100	acres of new grass.
100	.. 2-year old grass.
100	.. oats.
100	.. { 80 acres turnips.
	{ 10 .. potatoes.
	{ 10 .. bare-fallow.
100	.. { 50 .. barley.
	{ 50 .. winter and spring wheat.
500	

Grass-seeds 7 lb. of red clover, 5 lb. of white clover, 1½ bushel of perennial rye-grass per acre, which, over 100 acres, gives of—	
White clover, 4 cwt. 52 lb., at 52s. per cwt.,	£11 13 0
Red clover, 6 cwt. 28 lb., at 68s. per cwt.,	21 5 0
Rye-grass, 18 qrs. 6 lb., at 20s.,	18 3 0
	51 1 0
Hay for horses until they go to grass at the end of May, 5 tons, at £3 per ton,	15 0 0
Oats, 40 qrs., at 16s.,	32 0 0
4 Tons 4 cwt. seed-potatoes, at £2 per ton,	8 8 0
Men's wages from March until May 26, 1850, } 28 0 0	
7 Men 8 weeks, at 10s. per week, }	
Field-workers, from do. to do.,	7 0 0
Blacksmith's work, from do. to do.,	3 0 0

5371. May 1850.—

Share of the expenses of arbitration on fences and buildings,	2 0 0
Cost of 120 lb. Swedish turnip-seed, at 1s. per lb.,	6 0 0
.. 30 lb. yellow, at 1s. per lb.,	1 10 0
.. 90 lb. globe, at 9d. per lb.,	3 7 6
12 Tons guano, at £10,	120 0 0
200 Bushels bone-dust, at 2s. 6d. per bushel,	25 0 0
Poultry,—geese at 2s. 6d., goslings at 1s., turkeys at 3s., young turkeys at 1s., ducks and hens at 1s., and ducklings and chickens, 6d.,	5 0 0
1 2-year old colt or filly, for the draught,	18 0 0
1 1-year old do. do. do.,	12 0 0
1 Short-horn bull,	25 0 0
9 Short-horn cows, at £14 each,	126 0 0
20 Short-horn calves, part unweaned, at £2, 15s. each,	55 0 0
20 Short-horn 1-year old steers and heifers, at £6 each,	120 0 0
120 Leicester ewes and their lambs, at 45s. each,	270 0 0
160 Leicester ewe and wether hogs, at 32s. each,	256 0 0
2 Leicester tupps,	10 0 0
Servants' corn paid at May 26, 1850, in advance,—	
10 Servants at 1 qr. 1 bush. barley each, = 11 qrs. 2 bush., at 24s.,	13 10 0
3 bush. pease each, = 3 qrs. 6 bush., at 26s.,	4 17 6

Carry forward, £1975 5 6

	Brought forward,	£1975	5	6
7½ qrs. oats each, = 75 qrs., at 16s.,			60	0
½ Year's poor-rate,			10	0

5372. June 1850.—

3 Scythes for mowing grass, at 10s. each,	1	10	0
8 Hay-rakes, at 1s. 6d. each,	0	12	0
1 Horse hay and stubble rake,	3	15	0
1 Long ladder, 20 feet long, at 9d. per foot,	0	15	0
1 Half-long do., 12 feet long, at 9s.,	0	18	0
6 Short do., at 5s. each,	1	10	0
1 Sheep-crook,	0	3	6
1 Bathing-stool,	0	10	0
2 Baths for picking wheat, and for bath for sheep,	0	15	0
2 Picking baskets, at 3s. each,	0	6	0
2 Pair of wool-shears,	0	6	0
1 Beam, scales, and weights, for wool,	2	10	0
1 Buisting-iron and tar-kettle for sheep,	0	3	0
2 Hangers, and skewers for sheep when slaughtered,	0	2	0

5373. July 1850.—

2 Potato-graips,	0	6	0
9 Baskets for potatoes, at 9d.,	0	6	9
10 Turnip-hoes for women, at 1s. 2d. each,	0	11	8
10 Weed-hooks for weeding corn, at 6d. each,	0	5	0
4 Rope-twisters, at 2s.,	0	8	0

5374. September 1850.—

6 Straw-racks for cattle in courts, at 10s.,	3	0	0
1 Turnip-rammer, 14s., and trochar, 3s. 6d., for cattle,	0	17	6
1 Turnip-cutter for sheep,	5	0	0
1 Do. cattle,	1	10	0
6 Turnip-pickers, at 2s. each,	0	12	0
6 Knives for topping and tailing turnips, at 1s. 6d. each,	0	9	0
2 Hay-racks for sheep, at 30s. each,	3	0	0
20 Sheep-troughs, at 6s.,	6	0	0
300 Net-stakes, at 1d. each,	1	5	0
20 Sheep-nets, at 7s. 6d. each,	7	10	0
1 Mallet for driving stakes,	0	2	6
1 Driver for stakes,	0	5	0
1 Hay-knife,	0	3	6
1 Chaff-cutter,	8	10	0
2 Stable lanterns, at 3s. 6d. each,	0	7	0
3 Others, 1 for steward, 1 for shepherd, and 1 for cattleman,	0	10	6
1 Horn for blowing at fodder time,	0	2	0
1 Drill-machine for sowing corn,	7	0	0
3 Qrs. 5 bush. of seed-wheat, at 45s.,	8	3	0

5375. May 1851.—

2 Sows, 1 boar, and 4 shotts,	10	0	0
14 Calves for rearing, at 25s.,	21	0	0
Oats for 6 pair of horses 1 year, from April last year, at 34 qrs. per pair = 204 qrs., riding-horse, 23 qrs., in all = 227 qrs., at 16s.,	181	12	0
Seed-oats, 100 acres, at 5 bush. per acre = 62½ qrs. at 16s.,	50	0	0
Seed-wheat, 40 acres, at 3 bush. per acre = 15 qrs. at 45s.,	33	15	0
Seed-barley, 50 acres, at 3 bush. per acre = 18 qrs. 6 bush., at 24s. per qr.,	22	10	0
Clover seeds same as last year,	51	1	0
Lime for one year,	20	0	0
Tolls,	5	0	0
1 Year's poor-rate,	20	0	0
1 Do. road-money,	5	0	0
1 Do. schoolmaster's salary,	1	0	0
1 Do. assessed taxes,	2	10	0
1 Do. insurance,	1	10	0
1 Do. mole-catching, at 7s. 6d. per 100 acres,	1	17	6
1 Do. blacksmith work for 6 pair of horses, at 60s. per pair, also for riding-horse and other jobs, 60s.,	21	0	0
Oil, grease, and tar, for one year,	2	10	0
Bath for sheep, 440 sheep at 1½ each,	2	15	0
Money-wages of 10 men-servants for the 1st year,	74	0	0
Do. of 8 women, £6 each for the 1st year,	48	0	0
Do. of other field-workers in summer,	5	0	0
Corn for 8 men, ½ year,	24	0	0
Oats for horses from May to harvest, 45 qrs., at 16s.,	36	0	0

Carry forward, £2747 13 11

		Brought forward,	£2747 13 11
5376. To Harvest 1851.—			
Threshing machine, with hummeller and bruiser, 6-horse water power,		140	0 0
If of high pressure steam,	£210		
If of horse power,	120		
Dressing-fanners,		7	0 0
1 Barn-steelyard and weights,		6	0 0
1 Hand-hummeller,		0	10 0
60 Corn-sacks, at 1s. 6d. each,		4	10 0
1 Sack-barrow, with wheels,		1	10 0
2 Hand-barrows for lifting sacks of corn, at 10s. each,		1	0 0
4 Barn weights for filling corn, at 1s. 6d. each,		0	6 0
2 Oat wire-riddles, at 2s. each,		0	4 0
2 Barley do., at 2s. 4d. each,		0	4 8
2 Wheat do., at 3s. 3d. each,		0	6 6
2 Sieves do., at 2s. 6d. each,		0	5 0
1 Slap-riddle, at 2s.,		0	2 0
1 Barn-stool,		0	3 0
1 Wooden hoe, for corn,		0	1 0
1 Large barn-sheet,		0	12 0
2 Chaff-sheets,		0	7 0
6 Barn brooms,		0	3 0
2 Corn shovels, at 3s. each,		0	6 0
6 Sack needles, and clew of twine,		0	2 0
1 Furnace pot and grate,		1	5 0
1 Meal ark,		3	0 0
10 Cwt. of oatmeal at 9s. 7d. per bag,		4	15 10
Carry forward,		£2920	6 11

		Brought forward,	£2920 6 11
28 Pairs of reapers' blankets, at 7s.,		9	16 0
6 Porridge kits for reapers, at 3s. each,		0	18 0
6 Milk tins, 2s. each,		0	12 0
6 Small-beer barrels, 3s. each,		0	18 0
1 Gantress for large beer barrel,		0	3 0
Joiner and mason's work for 1½ year,		10	0 0
Tenant's share of the expense of drawing out the lease,		10	0 0
Half-year's rent, paid Lammass 1851,		625	0 0
Reapers' wages upon 200 acres, 5s. per acre,		50	0 0
Incidental expenses for 1½ year,		30	0 0
		£3657	13 11
5377. During the expenditure of the above sums, the following products have been sold off the farm:—			
2 Years clip of wool, 270 fleeces each year, = 540 at 6 lb. each = 3240 lb., at 1s. per lb.		£162	0 0
150 Sheep sold at 35s. each,		262	10 0
20 Sheep died, sold for,		10	0 0
20 Fat cattle, at £15 each,		300	0 0
Pigs sold,		20	0 0
5 Cwt. cheese, at 50s. per cwt.,		12	10 0
		767	0 0
Making the balance of outlay to amount to		£2920	13 11

5378. The sum actually passed through the hands of the new tenant in the first $1\frac{1}{2}$ year after entry to the farm is £7, 6s. $3\frac{3}{4}$ d. per acre, and that actually laid out by him is about £5, 15s. 8d. per acre; beside the sum required to furnish his house.

ON CHOOSING THE SITE, ON BUILDING,
AND ON THE EXPENSES OF ERECTING
THE STEADING.

5379. In ordinary circumstances, after a farmer has stocked and fully entered on his farm, he has little to do but to manage it in the best manner in the mode of farming he has chosen, or been obliged to adopt, (52,) and very few farmers have the opportunity of laying out a farm entirely from its commencement; but although you may not be involved in the necessity of originating a farm, it is not improbable that the one you have engaged may require either a new steading, new enclosures, draining, subsoil and trench-ploughing, or waste land to improve—in which case, you should be able to meet whichever of those exigencies may occur. I had to meet them all; for on the farm of Balmadies, which I occupied in Forfarshire, I had to build a new house, new steading, form new fences, construct embankments, make new farm roads, trench-plough, and improve waste land. He who has more than one of these operations to undertake, will find

little leisure for any amusement until they are finished. I will suppose, then, you have all these things to do, and in doing them they must be undertaken in the order I have enumerated them. I say nothing on the building of a farm-house, the form and appearance of which being a matter of taste, with the exception of the working part of it—the kitchen, scullery, milk-house, and cheese-room—on which my sentiments have already been expressed in (4192) and (4193.) Let us proceed, then, to the erection of the steading, which of course must be suited to a 500-acre farm of mixed husbandry, the kind of farming we proposed to follow (52.)

5380. It is a necessary condition, to its proper use, that every steading be *conveniently placed* on the farm. To be *most* conveniently placed, in theory, it should stand in its *centre*; for it can be proved in geometry, that, of any point within the area of a circle, the centre is the nearest to every point in the circumference. In practice, however, circumstances greatly modify this theoretical principle. For example, if an abundant supply of water can be easily obtained for the moving power of the thrashing-machine, the steading may be placed, for the sake of economising horse labour, in a more remote and hollow spot than it should be in other circumstances. For the purpose of conveying the manure downhill to most of the fields, some think

the *highest* ground near the centre of the farm as the best site for the steading. Others prefer the *lowest* point near the centre, because the grain and green crops being then carried downhill to the steading, the labour would be less than carrying them uphill, and they are heavier than the grain crops and manure. In selecting either of these sites, it seems to be forgotten that loads have to be carried both *to and from* the steading; so that either position will answer, provided there be no steep ascent to or descent from the steading. The lower situation, however, is more consonant with experience and reason than the higher; though level ground affords the easiest transit to wheel-carriages. It is desirable for the farm-house to be situated so as to command a view of every or most of the fields on the farm, that the farmer may have constantly a bird's eye view of them; and if circumstances permit, especially a plentiful supply of good water, the vicinity of the farm-house should be the site for the steading; but if a sacrifice of the position on the part of either is necessary, the farm-house should give way to the convenience of the steading.

5381. On referring to the accommodation required in the steading for the cattle in (1082;) for the horses, in (1389;) for the pigs, in (1574;) for the poultry, in (1598;) for the grain, in (1678;) for young calves, in (2271;) for farrowing sows, in (2845;) and for the wool, in (3940,) in the respective apartments shown in the ground-plan in Plate II., I need here only refer to those places for the mode of fitting up each of these apartments, and shall proceed to enunciate the leading *principle* on which these arrangements should be made; and being simple, it will best be understood when looking at the ground-plan in Plate II.

5382. Straw being the bulkiest article on the farm, and in daily use by every kind of live-stock, and, although heavy and unwieldy, having to be carried and distributed in small quantities by bodily labour, it should be centrally placed, in regard to the stock, and at a short distance from their respective apartments. The *straw-barn*, its receptacle, should thus occupy the central point of the steading. The

several apartments containing the live-stock should be placed, in respect of distance to it, according to the wants of the stock for straw, in order to save labour in its carriage; for so bulky and heavy an article as straw should in all cases be moved to short distances, and not at all from any other apartment than the straw-barn; so that the *thrashing-machine*, (1738,) which deprives the straw of its grain, should be so placed as at once to deposit the straw into the straw-barn; (1690.) The *stack-yard*, containing the unthrashed straw with its corn, should be contiguous to the thrashing-machine. The passage of straw from the stack-yard to the straw-barn through the thrashing-machine being directly progressive, it is a material consideration in the saving of time to place the stack-yard, thrashing-machine, and straw-barn in a right line.

5383. Different classes of stock require different quantities of straw, to maintain them in the same degree of cleanliness and condition, so that *those classes* which require the *most* should be placed *nearest* the *straw-barn*. The younger stock, including those in the hammels N, requiring most straw, receiving it largely for fodder as well as litter, the courts which they occupy should be placed contiguous to the straw-barn, one occupying each side of it. The older or fattening cattle requiring the next largest quantity of straw, the hammels M which they occupy should be placed next to the courts in nearness to the straw-barn. Horses and cows requiring the smallest quantity of straw, the stables O, and byres Q and Y, may be placed next farthest in distance to the hammels from the straw-barn.

5384. The positions of other two apartments are necessarily determined by that of the thrashing-machine, the one being the upper barn, which contains the unthrashed corn from the stackyard, ready to be passed through the mill; and the other the corn-barn, which receives the corn immediately after its separation from the straw by the mill. The granaries should be in direct communication with the corn-barn, to save the labour of carrying the clean corn to a distance. Fig. 133 shows the relative positions of the corn-barn and granaries on a larger scale than

the plate, where x is the corn-barn, m and p stairs to the granaries, $e e$, fig. 130, r the window in the corn-barn, t the chaff-house, and s the straw-barn. The granaries should always be elevated above the ground, to keep the grain in good condition, and it enables their floors to form convenient roofs for cattle or cart-sheds. The elevation which the granaries give to the building should be taken advantage of to place them so as to shelter the cattle courts from the N. wind in winter; and in order to afford the warmth of the sun to the cattle, all their courts should be open to its light and heat. The courts being open to the S., and the granaries forming a screen from the N., it follows that the granaries should extend E. and W. on the N. side of the courts; and as it has been shown that the cattle-courts should be placed on each side of the straw-barn, it also follows that the straw-barn, to be out of the way of screening the sun from the courts, should stand N. and S., at right angles to the S. of the granaries. The fixing of the straw-barn to the S. of the granaries, and of course to that of the thrashing-machine, the position of the stackyard is necessarily fixed to the N. of both, where it is favourably situated for the preservation of the corn in the stacks.

5385. The leading principle involved in the above arrangement is as comprehensive as simple, and is applicable to every size and kind of steading. But, obviously correct as the principle is, it is seldom adopted in practice; and I may safely assert that the greater the deviation from the principle, the less desirable steadings become as habitations for live stock in winter.

5386. One reason why steadings are not constructed on correct principles is, possibly architects who supply plans are unacquainted practically with the use of the respective apartments of steadings; and they commonly bestow too much attention on their symmetrical proportions, on constructing them at the least possible cost, and within the least space, as if a few square yards of ground were of much value in the country. No doubt economy is enforced on them by reluctant proprietors, as well as by poor tenants, when either have to construct the steading at their own cost; but economy of

construction is a secondary consideration, and the proper accommodation for live stock ought never to be sacrificed to it. For, suppose that, by inadequate accommodation, cattle thrive by 10s. a-head less in the course of a winter, than they would have done in well-constructed courts and hammels, and suppose that the farmer is prevented realising this sum on three lots of twenty cattle each of different ages, there is an *annual loss* to him of L.30; and had the capital sum, of which the annual loss of L.30 is the yearly interest, been expended in constructing the steading in the best manner, the loss would not only have been averted, but the cattle would have been in much better health and condition to slaughter or to fatten on grass. So little is such a result anticipated in constructing steadings, that in many parts of the country, the cattle courts are placed within a quadrangle, the southern range of which prevents the rays of the sun ever entering them; and on account of that peculiar form the chilly air rushes over the corners of the roofs into the courts in whirlwinds, which, if accompanied with rain or sleet, is sure to engender in the cattle the most insidious diseases.

5387. It is easy to apply the principle spoken of to the construction of steadings suitable to all the other modes of farming besides the mixed husbandry. For example, the steading for the arable part of a pastoral farm, where its extent is considerable, should be arranged as one for an arable farm situate at a distance from a town, as in fig. 55. Most of the straw being required for the stables g and i , the straw-barn e is placed nearer them than to the byre l ,—the young stock of cattle, should-cattle be bred on the farm, being accommodated in an appropriate steading with any number of courts—such as n and m in fig. 95—by itself, not far off.

5388. Where the arable part of a pastoral farm is small, the steading should contain all the stock in aggregate. Fig. 95 represents such a steading, where b is the straw-barn near the courts m , which contain the cattle that consume the largest proportion of the straw in fodder and litter. The stables d and f , and byre h , are situate farther off, as they require less straw than the courts; but to render

the carrying of the straw to those still more convenient than is shown in the plan, the straw-barn *b* might be made as much longer as to allow a door on each side of it, outside the courts *m*, to afford access to the straw from the more distant of those courts.

5389. On a carse farm the straw is the chief ingredient at the steading, and the principle means of using it are the horses, of which a large number is required on such a farm. The stable *f*, fig. 96, is placed near the straw barn *d*, to which two doors give access outside the courts *l*, in which the cattle pass the winter, and are also near the straw. The byre *i* is at no great distance.

5390. The construction of a dairy farm steading is peculiar, as is shown in fig. 384. The principal part of the steading, the byre *a*, is so situate as to be near the cooking house *b*, and the fodder house *e*, in which the hay is chopped by means of the cutter *f*, and which is necessarily contiguous to the moving power at *p*. The straw being most used by the stables *w* and *y*, the straw barn *s* is placed near them; and it would there be also near any hammels that might be erected in the open space within the ranges of the building, for the young queys coming forward to renew the stock of cows. The byre *a* is situate at no great distance from the door of the straw-barn *s* which affords it litter.

5391. The best way of building a steading is not to contract for it in a slump sum, because, whatever alterations may be made during the progress of the work, the contractor might take advantage of the change, and charge whatever he chooses for them, without your having a check upon his undefined rates; nor, for the same reasons, should the mason, carpenter, and slater works be contracted for separately in the slump. The *prices per rod or per yard, and the quantities of each kind of work, should be settled beforehand with the contractor.* The advantage of this arrangement is, that the work will be finished according to the views and tastes of the party for whose use the farmstead has been built, he having used the power of adopting such slight modifications of the plan, during the progress of the work,

as experience and reflection may have suggested; although the plan may have appeared well enough adapted for the purpose, but which may have overlooked many essential particulars of accommodation and comfort. The contractor cannot complain when he is paid for the work he has actually executed. An ordained surveyor, mutually chosen by both parties, then measures the work, calculates its several parts according to the prices stipulated for with the contractor, and draws up a report of the value of each kind of work, the total sum constituting the cost of the farmstead. Instalments of payment are made to the contractor at such periods of the work as were agreed upon. This plan may give you no cheaper steading, but a dearer one than the common plan of contracting by a slump sum; but cheapness should not be the principal object of building a steading, that being the convenience of the workpeople, and the comfort of the live-stock.

5392. What I mean by essential particulars of accommodation and comfort in a steading are such as these:—In giving a foot or two more length to a stable or byre, by which each animal may have two or three inches more room laterally, when it would enjoy more ease and comfort. A window, instead of looking to the cold north, may be made with as much ease to look to the warm south. A sky-light might be made in the roof, to afford sufficient light to a place that would otherwise be dark; an additional drain to remove moisture or effluvia, which, if left undisturbed, might cause considerable annoyance. A door opening one way instead of the other, may direct the draught of air to a quarter where it can do no harm. A door made of a whole piece, instead of being divided into leaves, may make a chamber gloomy; and the leaves of a door formed horizontally, instead of vertically, when left open, may give security to an apartment against the intrusion of every passer-by. These and numerous such small conveniences may be obtained during the construction of a steading, without which it would want much of its commodiousness and comfort—and which it would most likely want, were the farmer bound by a contract to a specified sum.

5393. Before the prices of work to be

executed can be fixed on between the employer and contractor, *specifications* of every species of work should be drawn up by a person competent for the task. A vague specification, couched in general terms, will not answer; for when work comes to be executed under it, too much liberty is given to both parties to interpret the terms according to the interest of each. Hence arise disputes, which may not be easily settled even on reference to the person who drew up the specifications, as he possibly by that time may have either forgotten his own ideas of the matter, or, by intimating his original intentions, may so affect the interest of both parties as rather to widen than repair the breach. Far better have every particular embodied in the specifications, than have explanations and modifications to make afterwards.

5394. The *principle* of the measurement to be applied to the work is another item to be embodied in the specifications. It is too much the practice, in some parts of the country, to tolerate a loose mode of measuring work; such as measuring *voids*, as the openings of doors and windows are termed, that is—on measuring a wall for the rubble-work, to include all the openings in it, and then to measure the lintels and ribs and corners. In like manner, chimney-tops are measured all round as rubble, and then the corners are measured over and above. Now the fair plan obviously is to measure every sort of work by itself: where rubble is, let it be measured for rubble; and where hewn work is, let it be measured as such. The hewn stones assist the rubble building, and as they cost more at the quarry than rubble stones, let a fixed price be settled for them. Thus the work actually done would be paid for; and more should not be paid, let the price of the work be what it may. I am glad, however, to add that the practice now, in all the towns of Scotland, is to measure all work in nett measure; that is to say, in measuring rubble work the cubical contents of both rubble and hewn work are measured, and the daylight of all voids deducted. The exceptions are, in the wall presses, fire-places, window-bossings, and flues of chimneys are included in the measurement. All walls above 18 inches thick are reduced to a standard of 2 feet, and all walls below 18 inches thick

are reduced to a standard of 12 inches. Rubble work is always charged by the rood of 36 square yards. In measuring rubble, allowances for levellings connected with joists, bond timbers, and wall-plates are now abolished. As to hewn work, ribs of doors and windows, sills, lintels, corners, copes of chimney-stalks, skews, and wall-head copes are measured and priced by the lineal foot. Coursing, chimney-head ashler, and every other work of similar description, is measured and priced by the superficial foot. In inside work, pavements, flats of stairs, and hearths, are measured and priced by the superficial foot. Steps and jaubs are priced by the slump. Stone skirtings are measured and priced by the lineal foot.

5395. The following *specifications* are applicable to every size and plan of steading; and as they accord with my own experience, which has been considerable on this subject, I submit them with the greatest confidence. They embrace the particulars of mason work, carpenter work, slater work, plumber work, smith work, and painter and glazier work, which are not drawn up in the phrases usually employed in specifications, but are illustrated by examples and by the elucidation of principles. Proper specifications could easily be drawn out from the data furnished here.

5396. *Mason-work*.—The first thing to be done in mason-work is the *digging of the foundations of the walls*. When the site of the steading is not obliged to be chosen on a rock, the depth of the foundations of all the outside walls should never be less than two feet. Judging by usual practice, this may be considered an inordinate depth, and as incurring much expense in building an unnecessary quantity of foundation walls, which are immediately after to be buried out of sight. But this depth is necessary on account of the drains which should be made around the outside walls, to keep all the floors dry in winter; and it is scarcely possible to keep them dry with drains of less depth than 30 inches, which afford the water a channel of 6 inches below the bottom of the foundations. The ground-floor of dwelling-houses may be kept in a dry state by elevating it a considerable height above the ground; but such an expedient is impracticable in a steading where most of the apartments, being occupied by live stock, must be kept as near as possible on a level with the ground; and it is not wood-floors alone that must be kept dry, but those of sheds, barns, and byres, whether made of composition, of causeway, or of earth. The injurious effects of damp in the floors of stables, byres, and hammels, on the condition of the animals inhabiting them in winter, or of barns on the state of the straw, corn, or hay in them, are too much overlooked. Its malign influence on the health of animals, or in retarding

their thriving, not being apparent to the senses, it is apt to be ascribed to constitutional defect in the animals themselves, instead of, perhaps, to the truer cause of the unwholesome state of the apartments which they occupy, (5386.) The truth is, the floor of every apartment of the steading, whether accommodating living creatures, or containing inanimate things, cannot be too dry; and, to render them as much so as is practicable, there seems no way of attaining the end so effectually as by digging the foundations of the walls deep, and surrounding them with still deeper drains. There are many substances upon which walls are usually founded, which, from their nature, would make walls constantly damp, were expedients not used to counteract their naturally baleful properties. Amorphous rocks, such as granite, which are impervious to water; trap rocks, which, though frequently containing minute fissures, being deliquescent, become very damp in wet weather; clay, and tilly clay even more than the unctuous, retains a great deal of water: all these substances form objectionable ground upon which to found any building. Stratified rocks, such as sandstone, not retaining the water long, form drier substances for a foundation than any of the amorphous rocks or clays. Pure sand is not always dry, and is apt to form, in some situations, an insecure foundation. Pure gravel is the driest of all foundations, but not the most secure. From the nature of these various substances, excepting the gravel, it would appear that no wall founded on them can assuredly be kept dry at all seasons; and therefore drains are necessary to render and keep them so. A foundation made in a bank of even the driest gravel will prove damp, unless the precaution of deep draining betwixt the foundation and the rise of the bank is resorted to. Rather than choose a site for your steading which is overhung by a bank, make a deeper foundation on more level ground, and drain it thoroughly, or even build some height of waste wall, and fill up a part of the ground that is low around the steading. I have experienced the bad effects of digging a foundation for a steading in a rising ground of tolerably dry materials, and also the good effects of filling up low ground at a part of another steading, and have found the air in the apartments of the latter at all seasons much more agreeable to the feelings than in the former. The bad effects of the former I endeavoured to counteract by deep draining, but it was not so effectual as in the latter case. I am therefore warranted in concluding that dry apartments are much more healthy for animals, and better for other things, than are those which feel cold and damp. A circling of substantial drains around the steading, between it and the bank, will render the apartments to the feelings, in a short time, in a comparatively comfortable state.

5337. The *outside walls should be founded with stones* three feet in length, two in breadth, and eight or nine inches in thickness, so laid, in reference to the line of foundation, as to form a scarcement of six inches on each side of the wall above them. The low walls may stand on one

course of such foundation, whilst the higher walls should have two such courses.

5398. *All the walls, both external and internal, should be built of the best rubble work*, the stones being squared, laid on their natural beds, closely set in good lime mortar, and well headed and packed. Headers, or band-stones, should go through the thickness of the walls at not more than five feet apart in every third course. The walls should only be built one course in height on one side, before the other side is brought up to the same level, the first of the courses to go through two-thirds of the wall, besides the headers.

5399. The *external walls should be 2 feet in thickness*, and the *internal division walls*, as also the walls composing the fronts and subdivisions of the courts and hammels, 1 foot. In exposed situations, the walls should be 2 feet 3 inches thick. The low external walls should be raised 9 feet, and the high external walls of the middle range, as well as that of the straw-barn, 15 feet above the ground. All the gables of the external walls, and all the internal division walls, should rise to the pitch of their respective roofs, and be filled up to the sarking. The front and side walls of the large courts and bulls' hammels, and the subdivision walls of the courts of the hammels, should be raised 6 feet, and the front walls of the hammels, as also those of the cows' and calves' courts and pig-sties, 5 feet above the ground. All the walls which carry roofs should be beam-filled with rubble work, as a precaution against the lodgment of vermin, (1681.)

5400. The *external fronts* of all the outside walls, as well as those of the front walls of the courts and hammels, should be faced with *hammer-dressed rubble in courses*, not exceeding 6 inches in thickness, with the vertical and horizontal joints raised or drawn in hollow. Or the rubble work may be neatly snecked, and carefully drawn in with a quarter inch key, and pointed. The tops of the front and subdivision walls of the courts and hammels should be finished with a *coping* of hammer-dressed round-headed stones, 12 inches in diameter, firmly set close together in good lime mortar.

5401. To test if rubble masonry is well built, step upon a levelled portion of any course, and, on setting the feet a little asunder, try by a searching motion of the legs and feet whether any of the stones are loose, and whichever is so rides upon others. Where a stone rides, it has not been properly bedded in mortar. To ascertain if any hollows are left, pour a bucketful of water on the wall, and those places which have not been sufficiently packed with small stones, will immediately absorb it.

5402. The *width of all the doors* should be 3 feet 6 inches, and their height 7 feet, with the exception of those of the work-horse stable, corn-barn, straw-barn, and saddle-horse stable, which should be 7 feet 6 inches in height. The

width of the arches of the cattle-courts should be 9 feet; that of those of the hammels, 6 feet; and that of the ports of the cart-shed, 8 feet; and all 7 feet 6 inches in height.

5403. The *width of all the windows* should be 3 feet, and their height four feet, with the exception of those of the granaries, which should be 4 feet in width and 3 feet in height. The windows should have a bay inside of 6 inches on each side. Slits of 1 foot 3 inches in height and 3 inches in width in front, with a bay inside like the windows, should be left in the walls of the straw and upper barns for the admission of air to the straw and the corn in the straw. All the voids should have substantial discharging arches over the timber-lintels, to be able to support the wall above, even although the timber-lintels should fail.

5404. All the *door-soles* should be laid 3 inches above the ground or causeway, and those of the stables and byres and calves'-house should be bevelled in front, that the feet of the animals going out and in may not strike against them.

5405. The *corners of the buildings* should be of *broached ashler*, neatly squared, 2 feet in length, 12 inches of breadth in the bed, and 12 inches in height, having 1 inch chisel draught on both fronts. The *windows and doors* should have *ashler ribs*, the outbands 2 feet in length, and the inbands at least two-thirds of the thickness of the walls, and both 12 inches of breadth in the beds, and 12 inches in height. They should have 1 inch of the front, 5 inches of ingoings, and 4 inches of checks, clean droved. The tails of the outband ribs should be *squared and broached*. The doors of the work-horse and saddle-horse stables, upper and corn-barns, hay-house, bulls' hammels, byres, and calves' house, should have droved giblets-checks, to permit them opening outwards. The *window sills* should be droved, projecting 1½ inch, and 6½ or 7 inches in thickness. The *lintels* of both the doors and windows should have 1 inch of the front, 5 inches of ingoings clean droved, and be from 14 to 15 inches in height.

5406. The *skews* should be broached when such are used, having 1 inch chisel-draught on both margins of the front, and the inner edge with a 4-inch check-plinth, having an inch of back-rest under it.

5407. The *holes in the byre-wall*, through which the turnips are supplied, when such are used, should be 20 inches square, with ashler ribs, flush sills and lintels, having broached fronts and droved giblets-checks to receive their shutters.

5408. The *side corners of the arched openings* of the cattle-courts and hammels, and those of the ports of the cart-shed, should be regular out and inband, 2 feet in length, 12 inches of breadth in the bed, and 12 inches in height, and dressed in a manner similar to the other corners, but should be chamfered on the angles. The *arches*

should be elliptical, with a rise of 2 feet, with broached soffets on both fronts, an inch-droved margin, and radiated joints. The *pillars of the cart-shed and calves'-shed* should be 2 feet square in the waist, of broached ashler, with inch-droved margins, and built of stones 12 inches in height. Those of the former should have a droved base-course, 12 inches in depth with 1½ inch washing, chamfered on the angles.

5409. The *tops of the walls of the pig-sties, calves'-shed, hen-houses, and turnip-stores*, should have a 6-inch droved plinth 12 inches in the bed.

5410. The *fire-places in the boiling-houses and gig-house* should have a pair of droved jambs and a lintel, 3 feet 6 inches of height in the opening, and a droved hearth-stone 5 feet in length and 3 feet in breadth. The *boiler* should have a hearth-stone 4 feet 6 inches in length, and 2 feet 6 inches in breadth, and it should be built with fire-brick, and have a cope of 4 inches in thickness of droved ashler. Fig. 114 in (1467) represents a common mode of finishing the boiler without the coping; but the stone coping makes the strongest finishing. The *flues* from all the fire-places and the boilers should be carried up 12 inches clear in the opening, and have chimney-stalks of broached ashler, 2 feet in height above the ridges of the respective roofs, 2 feet square, and furnished with a droved check-plinth and block 12 inches in depth. What is better is, to make the flues of fire-clay tubes, 10 inches in diameter inside; and at this size they can be put in at 10d. per lineal foot.

5411. The *gates of all the cattle and hammel courts* should be hung on the droved ashler corners when close to a house, but on droved built pillars when in connection with low court-walls.

5412. The *riding-horse stable*, if laid at all with *flags*, should have them 4 inches thick, of droved and ribbed pavement behind the travis-posts, having a curved water-channel communicating with a drain outside. The *travis-posts of the work-horse stable* should be provided with droved stone *sockets* 12 inches in thickness, and 18 inches square, founded on rubble work, and a droved *curb-stone* should be put betwixt the stone sockets of each pair of head and foot travis-posts, provided with a groove on the upper edge to receive the under edge of the lower travis-board. For the better riddance of the urine from the work-horse stable, there should be a droved curved *water-channel* 6 inches in breadth, wrought in freestone, 18 inches in breadth, all the length of the stable, with a fall at least of 1½ inch to every 10 feet of length. The *water-channel in the cow-byres, and in the feeding-houses*, when such are used, should be of droved curb-stones 6 inches thick, 12 inches deep, and laid in the bottom with 3-inch thick of droved pavement, placed 6 inches below the top of the curb-stones.

5413. The *water-troughs* should not be of less dimensions than 3½ feet in length, 2 feet in breadth, and 18 inches in depth over all; and

they should be clean droved outside and inside. Wood or pavement may be substituted for stone when that cannot be easily obtained.

5414. The liquid manure *drains* should be 9 inches in height and 6 inches in width in the clear, with droved curved sills and hammer-dressed covers. Glazed earthenware tubes with spigot and faucet joints are beginning to be used for conveying the liquid manure to the tanks. A stone 2 feet in length, 18 inches in breadth, and 8 or 9 inches in thickness, with an opening through it, giblet-checked, will contain a *grating* 15 inches in length and 9 inches in breadth, with the bars one inch asunder, at the ends of the liquid-manure drains in the courts.

5415. The bottom of the *feeding-troughs* in the byres, courts, and hammels, should be of 3-inch thick flag-pavement, jointed and scabbled on the face, or of wood. All the *window-sills* in the inside should be finished with 3-inch droved or scabbled pavement.

5416. The *walls in the front of the courts* are intended to be quite *plain*; but should you prefer ornamental structures, their tops may be finished with a 6-inch droved cope, 15 inches in breadth, with a half-inch washing on both fronts; and with a droved base-course 12 inches in depth, having a washing of 1½ inch: the pillars of the gates to the larger courts may be of droved ashler, in courses of an octagonal form, of 15 inches in thickness, and 2 feet by 2 feet, with 12-inch base, and a 12-inch checked plinth and block, built at least 18 inches higher than the wall: and if you prefer an outside hanging-stair to the wool-room, the steps should be droved 3 feet 6 inches clear of the wall, with 6 inches of wall-hold: and you may substitute droved crow-steps on the gables for the broached skews, with an inch hack-rest under them. Crow-steps, in my opinion, are no ornaments in any case, in a stead-ing. They are only suited to a lofty castellated style of building.

5417. *Floors, and causeways, and roads.* The floors of the cow-byres, work-horse stable, stalls of the riding-horse stable, passage of the calves' house, gig-house, implement-house, hay-house, and turnip stores, should be laid in *causeway* with hammer-dressed squared whinstone, upon a solid stratum of sand, on a bed of broken stones, 12 inches thick, under it. The floors of the boiling-houses should be laid with 3-inch pavement jointed and scabbled on the face, also upon 12 inches thick of broken stones. A causeway, 13 feet in breadth, should be made in the large court K, Plate II., to the corn-barn door, round to the gate at the work-horse stable, for the use of loaded carts from the barn, with a declivity from the wall to the dung area of 2 inches in the 10 feet. Causeways are usually formed in steadings with round hard stones found on the land, or in the channels of rivers, or on the sea-shore, imbedded in sand. In those situations the stones are always hard, being

composed of water-worn fragments of the primitive and secondary as well as of trap-rocks; but round boulders of micaceous sandstone, usually found in gravel pits, are unfit for causeways, being too soft and slaty. A better stone is squared trap, whether of basalt or greenstone, imbedded in sand, such as are used in the streets of towns. The ready cleavage of trap-rocks into convenient square blocks render them valuable depots, where accessible, of materials for causeways and road metal. The floors of the pig-sties and poultry yards should be laid with thick, hammer-dressed jointed stones imbedded in lime mortar, having broken glass in it, upon a bed of 9 inches thick of small broken stones, to withstand not only the digging propensities of the pigs on the surface, but to prevent vermin gaining access from below through the floor to the poultry. The areas of the cattle courts, and floors of the sheds, hammels, straw-barn, and cart-shed, will be firm enough with the earth beaten down.

5418. A method of making the floors of out-houses, recommended by Mr Waddell of Berwickshire, deserves attention. It is this: Let the whole area of the apartment be laid with small broken stones to the depth of nine inches. Above these let a solid body of masonry, of stone and lime properly packed, be built to the height of 12 or 14 inches, according to the thickness of the substance which is to form the upper floor. The lime, which is applied next the walls, should be mixed with broken glass. If a composition is to form the floor, it should be laid on 3 inches in thickness above the masonry; but if asphaltum, 1 inch thick will suffice, the difference in the height being made up in the masonry.* This plan of Mr Waddell's seems well adapted for making a solid and secure foundation against vermin, for the paving of the several apartments mentioned above; but it is not so well adapted for wood-floors, either as a preservative against damp, or preventive against vermin, as the plan described in (1681.)

5419. Having seen several sorts of *concrete* used in the floors of barns and cottages, I am now of opinion that any such composition is unsuited to the purpose, and is far from durable.

5420. Asphalt floors not being suitable for dwelling-houses, or for any apartment in a stead-ing, I do not recommend them.

5421. Another mode of causewaying is *wood pavement*. Portions of the streets of London were laid with this kind of pavement, the blocks having been previously subjected to the process of Kyanising, and they made smooth, clean, quiet, causewaying; but its surface became so slippery in wet weather, and many accidents happening to horses, it was relinquished for ordinary causewaying. It can scarcely be said to have had a fair trial, because, being confined to a small space at one place, the dirt brought upon it by the wheels of the carriages from the macadamised streets in its vicinity was the real cause

* *Price Essays of the Highland and Agricultural Society*, vol. viii. p. 373.

of the slipperiness, and not from any substance that arose from its own surface. But however unsuccessful it may have been on the thronged streets of a large city, it would be a desirable method of paving the road round the large court K, Plate II., the straw-barn, work-horse stable, hay-house, cow-byres, passage in the calves'-house, riding-horse stable, gig-house, boiling-houses, and turnip stores. It would be expedient, when used in a stable or byre, that some other substance than sand be put between the blocks, as it would absorb the urine too readily. Grout formed of thin lime and clean small gravel, or asphalt poured in between the blocks, might repel moisture, as has been tried according to Mr Sinms. Gutta percha would be a most effectual binding for the wood blocks. Dr Ure says, "that slipperiness is not a natural defect in wood paving. The accumulations on wood pavement are drawn from the proximate wear of granite and macadam. In granite, the imperfect structure admits of the constant oozing of dust and filth; in macadam, the surface is always wearing into dust and slop. In very hot or cold weather the stone paved streets of London are proverbially as slippery as glass, whilst slipperiness in wood pavement is altogether obviated by cleanliness; and that may now be insured by the use of Whitworth's cleaning machine, which has already been successfully tried in some of the principal streets. It is impossible not to perceive the great amount of suffering and loss that may be saved in horses by the wood pavement. Cabmen and omnibus drivers assure us that, in the winter season, for a month or two only there is very serious cause of complaint, and then there is as much or more danger on other pavements; whereas, during the summer months, the advantage of wood over all other pavements is immense. The great mortality of horses in the streets of London, from overdriving during the hot weather, is well known; so far as wood is concerned, the reduction of effect must necessarily decrease the destruction in a greater ratio than even 5 to 2. The strength of wood pavement may be estimated by the fact that, in Scotland Yard, in London, no less than 78,000 tons per annum of traffic goes over the wood pavement there, where it is confined to a single carriage line—a test of the most critical description."* Wood-paving could be done in the country at a lower rate than any incurred in towns. To prevent slipping, small sharp gravel is occasionally strewn over the surface of Regent Street, in London; and it seems to answer the purpose.

5422. Another method still of causewaying is with *Dutch Clinkers*, a very hard brick made in Holland, of about the breadth and thickness of a man's hand. They are used in that country in paving roads and streets. They are set lengthways on edge and imbedded in sand, and so laid as to form a slight arch across the road. Most of the great roads in Holland are paved with this brick, and more beautiful and pleasant roads to travel on cannot be found anywhere, except per-

haps in the heat of summer, when they become oppressively hot. I had an opportunity of seeing a part of the road near Haarlem laid with these clinkers, and observed, as a part of the process, that, as a certain piece of the causewaying was finished, bundles of green reeds were laid lengthway across the road over the new laid bricks, to temper the pressure of the wheels of the carriages upon the bricks on going along the roads, until the bricks should have subsided firmly into the stratum of sand. As the clinkers are small, they can be laid in a variety of forms, some as a beautiful kind of Mosaic work. The import duty on Dutch clinkers is 10s. per 1000.† The price of clinkers in London in 1842 was 35s. per 1000. No mention has recently been made of their import, in the Parliamentary returns, probably because they are now made in England.

5423. Fine smooth durable pavement is made of the beautifully stratified beds of the inferior grey sandstone, a rock nearly allied to greywacke. It is a rock of fine texture, hard, and impervious to water. It occurs in abundance on Lord Panmure's estates at Carmylie, in Forfarshire; and it is shipped at Arbroath, from whence in consequence it has received the appellation of *Arbroath pavement*. Hard flags from the counties of Caithness and Orkney form very durable, though not always even pavement. Like the Arbroath pavement, it requires very little dressing on the face. The Caithness pavement is, from its hardness, obliged to be cut on the edge with a saw; the Arbroath pavement is dressed with common masons' tools. Pavement is also formed of the stratified portions of the sandstone of the coal-formation. Most of the foot pavement of the streets of Edinburgh is of this kind. Its face requires to be wrought with tools, and its texture admits water. Arbroath pavement costs from 2d. to 4d. per square foot at the quarry, according to the thickness. Both it and Caithness pavement cost 1s., and common stone pavement 8d. per foot in Edinburgh.

5424. All the roads around the steading, and especially where carting will pass along, should be properly made of a thick bed, of not less than 9 inches, of small broken whinstone metal, carefully kept dry, with proper outlets for water at the lowest points of the metal bed, and the metal occasionally raked and rolled on the surface until it becomes solid.

5425. Foot-paths of gravel or small broken metal, should be made to the farm-house and servant's houses from the steading, where these are not situate along the road-side. Such foot-paths afford much comfort and cleanliness in winter.

5426. *Drains*.—No steading can be dry and comfortable within its walls, unless a well-constructed drain is made to encircle all the outside walls. In the ground-plan of the steading, Plate II., the lines of drains, and the directions they should run, are shown by the directions of the

* Ure's *Dictionary of the Arts*, Supplement—art. *Wood-paving*.

† Clement's *Customs Guide*, p. 67.

arrows. The outlets of these drains should be as far removed from the urine tank as practicable, and fall into a ditch or rivulet at a level below that of the foundation of the steading. The drains should be dug as far from the walls as to be clear of the large foundation stones, and as deep as to be 6 inches below their under face, and as narrow as practicable. If the foundations are 2 feet deep, the drains will thus be 30 inches deep. They should be laid in the bottom with drain pipe-tiles of the size fitted for main drains, and be filled to the top with broken stones like road metal: for these drains are not, like field-drains, intended only to receive water after it has filtered through loose soil; but besides the water they may receive from the soil below, they must receive all the rain water that may fall in the course of the year from the eaves of the back part of the roof of the steading; for it is not to be expected that the expense of erecting drains will be incurred for that part of the building, so that these drains must not only take in what water is presented to them below the ground, but also what they may collect from the surface—and it is on this account that I recommend for their conduit the large main-drain pipe-tile. Being situate very near and under the protection of the high part of the steading-wall, the small stones which cover them will never be disturbed nor rendered impervious to water. I express myself thus confidently on this point, after experience of the efficacy of such drains for several years.

5427. The *kind of stone* which should be employed in the building of a steading must be determined by the mineral product of the locality. In all localities where stone is accessible, it should be preferred to every other material; but where its carriage is distant, and of course expensive, other materials, such as brick, must be taken. In large flat tracts of country, stone is generally at too great a distance; but in those situations, clay being abundant, brick may be easily made, and it makes an excellent building material for walls—and now that the duty on its manufacture has been entirely removed, it will be a cheaper material than it has ever been. Of stone, any kind may be used that is nearest at hand, though some rocks are much better adapted for building purposes than others.

5428. Of the primitive rocks, grey granite forms a beautiful and durable stone, as is exemplified in the buildings in Aberdeenshire, Cornwall, and Newry in Ireland. Gneiss, mica-slate, and clayslate, do not answer the purpose well. They give a rough edgy fracture, frequently rise too thin in the bed, especially in the case of clay-slate; are not unfrequently curved in the bed, and at the same time difficult to be dressed with the hammer.

5429. Of the transition series, greywacke makes a beautiful building stone, as may be seen in the houses at Melrose. The old red sandstone, though a good building-stone, has a disagreeably sombre aspect, as seen at Arbroath; but the inferior grey sandstone, which prevails

in the neighbourhood of Dundee, is a beautiful and durable building-stone.

5430. All the sandstones of the coal formation form excellent materials for building, as is exemplified in Edinburgh, and many other places.

5431. The limestones make fine building-stone—from marble, as at Plymouth, to the carboniferous mountain limestone, to be seen in many parts of Ireland; but, in case of fire, all limestones are apt to be calcined by heat, as was exemplified in the cathedral at Armagh, before it was lately repaired.

5432. Trap-rocks are employed in building houses, where sandstones are scarce. Whinstone is objectionable, inasmuch as it throws out dampness in wet weather, and the walls require to be lathed and plastered on the inside, to render the house even bearable. Frequently where whinstone is near at hand, and sandstone can be obtained at a little distance, the latter is employed as corners, ribs, and lintels, though the contrast of colour, when the stone is nearly white, betwixt them is too violent to be pleasant to the eye. If sandstone, therefore, can be procured at a reasonable cost of carriage, you should give it the preference to whinstone, for the sake of comfort to your live-stock in their habitations in wet weather. You may, indeed, choose to incur the expense of lathing and plastering all the insides of the walls of the steading; but a lathed wall in any part of a steading will be apt to be broken by accident, and is, on that account, an unsuitable finishing for it.

5433. The worst sort of building-stone are landfast boulders of the primitive and trap rocks, which, although reducible by gunpowder, and manageable by cleavage into convenient shaped stones, incur great labour in their preparation for building; and even after the stones are prepared in the best manner they are capable, their beds are frequently very rough, and jointings coarse, and the variety of texture and colour exhibited by them, render them at the best unsightly objects in a building; but they make a strong wall. When of sandstone, boulders are apt to become splintery, and are unsuited for associating with lime mortar.

5434. *Carpenter work.*—Of the specifications of carpenter work, the first timber that is used in building consists of *safe-lintels*, which should be 4 inches thick, of such a breadth as to cover the space they are placed over, and they should have a solid bearing at both ends of 12 inches.

5435. The *scantlings* or *couples* for the roofs vary in size with the breadth of the building. When the building is 18 feet wide, the scantlings should be 8 inches broad at bottom, 7 inches at top, and 2½ inches thick. Those for 15 feet wide buildings should be 7 inches broad. All scantlings should be placed 18 inches apart from centre to centre, upon *wall-plates* 8 inches wide by 1½ inch thick, firmly secured to *bond-timber* built into the tops of the walls. These dimensions and

distances of scantlings are suitable for a roof of blue slates. For a tile-roof the scantlings are placed 2 feet apart from centre to centre. For roofing with grey-slates, which are heavy, the scantlings should be 3 inches thick. With tiles and grey-slates the roofs require a higher pitch than with blue slates, which is given by making the scantlings 1 foot longer.

5436. The *balks* of an 18 feet wide building should be $7\frac{1}{2}$ inches broad by $2\frac{1}{2}$ inches thick, and for the 15 feet one, 7 inches by $2\frac{1}{2}$ inches. In both cases the balks should be of the length of one of the scantlings, which will bring its position so low down on the scantlings as to be only a little more than 3 feet above the wall-heads. It is generally supposed that one balk is sufficient for the support of the scantlings; but I would always prefer two balks to one, as in fig. 129, and the only objection to the two is the expense. When two balks are employed, the lower one will be about 2 feet, and the upper one about 5 feet above the wall-heads.

5437. When the slated roof is adopted, there should be a *ridge-tree* 10 inches broad by $1\frac{1}{2}$ inch thick; and the tops of the scantlings should be strongly secured to the ridge-tree by spike nails. When a tile-roof is preferred, it is sufficient that the tops of the scantlings be half checked into each other.

5438. The whole roof should be covered with *sarking*, $\frac{3}{4}$ inch thick, and clean jointed. A tile roof requires *tile-lath*, $1\frac{1}{4}$ inch square, and 12 inches apart, excepting at the eaves, which should have a boarding from 15 inches to 18 inches broad, and $\frac{3}{4}$ inch thick for slates. Tile-lath is also employed with grey-slates.

5439. The *peands* should be 8 inches broad, and $1\frac{1}{2}$ thick, properly backed to receive the sarking or tile-lath of the respective sorts of roofs. The *flanks* should be 11 inches broad, by 3 inches thick.

5440. The *joists* of the flooring in the part of the buildings that is 18 feet wide, should be 10 inches deep by $2\frac{1}{2}$ inches in thickness, placed 18 inches asunder from centre to centre, and having a wall-hold or rest of 12 inches at each end. Where the bearings of joists exceed 8 feet, it is a more secure and economical plan to have beams, instead of battens, laid across the building, 13 inches deep, and $6\frac{1}{2}$ inches in width, with a wall-hold of 12 inches at each end. Upon these should rest joists 7 inches deep, and $2\frac{1}{2}$ inches in breadth, and not more than 16 inches apart from centre to centre, dove-tailed into the beams with a hold of 9 inches at each end. These joists are best cut out of Memel log of first or second quality, the difference of price between the two qualities being 3d. the cubic foot.

5441. The *floors* of the upper and corn-barn and granaries should be of $1\frac{1}{4}$ inch thick, of red or white wood battens, grooved and tongued, and well seasoned when wrought and laid. The under side of the floor, and the joists which sup-

port the floor of the upper-barn, forming the roof of the corn-barn, should be clean dressed, to prevent the adherence of dust.

5442. In some parts of the country, and particularly in East-Lothian, the floor of the corn-barn is made of composition; but in order to leave a part of the floor clean upon which to winnow the grain, a space 12 feet square is usually left in the middle of the floor. This space is laid with sleeper-joisting, 7 inches deep by $2\frac{1}{2}$ inches thick, and 18 inches apart from centre to centre, supporting a flooring of deal 2 inches thick, grooved and tongued. As a precaution against vermin, as well as the enjoyment of cleanliness while winnowing and otherwise handling the grain, I would always recommend an entire wooden floor for the corn-barn, to be laid down in the manner described in (1681), and represented in fig. 129.

5443. The *windows* of the stables should be of the form of fig. 107; those of the byre as in fig. 77; and those of the granary as in fig. 131. The *astrogals*, if not made of wood, may be of cast-iron or zinc. Cast-iron astragals cost 1s., and zinc $9\frac{1}{2}$ d. the square foot.

5444. The *exterior doors*, $7\frac{1}{2}$ feet high, should be of $1\frac{1}{4}$ inch deal, grooved, and tongued, and beaded, having three back-bars, 7 inches broad by $1\frac{1}{4}$ inch thick; those of the corn-barn, cow-byre, and boiling-house should be in two horizontal leaves, that of the upper-barn in two vertical ones.

5445. If desired, small windows of one or two rows of panes may be placed above all the outside doors; in which case, the voids of these doors should be made proportionally high, say 8 feet.

5446. The *inside doors* should be 7 feet high, of $\frac{3}{4}$ inch deal, with three back-bars 6 inches broad and 1 inch thick, grooved, and ploughed, and beaded. They should have checks 6 inches broad by $2\frac{1}{2}$ inches thick, and keps and facings $4\frac{1}{2}$ inches broad by $\frac{3}{4}$ inch thick.

5447. The *travis boarding* of the work-horse-stable should be $1\frac{1}{2}$ inch thick, $9\frac{1}{2}$ feet long, 7 feet 6 inches high at the fore and 4 feet 6 inches high at the heel posts, doweled in the joints with oak pins, and of an ogee form on the top, let into a 2-inch deep groove in the heel-post, and coped with beading. The *heel-posts* should be 6 inches square, beaded; the *fore-posts*, on both sides, 5 inches by $2\frac{1}{2}$ inches, and both fixed at the top to *runtrees*, 6 inches deep by 2 inches broad. The side-walls of the end-stalls should be finished in the same manner, and firmly secured to wall-straps and bond-timbers.

5448. The *travis-boarding* of the riding-horse stable should be of the same strength as just described; but the heel-posts should be turned 5 feet high above the ground, with moulded caps and balls, and let from 18 inches to 2 feet into the ground, through a stone frame 18 inches square and 12 inches thick, firmly built with

stone and mortar. The fore-posts should be 3 inches in diameter on both sides to the height of the travis boarding. Heel-posts, as in fig. 106, are also made of cast-iron, which cost 22s. each.

5449. The *hay-racks* of the work-horse stable should have a hardwood rail, 3 inches deep by 2½ inches wide, and the spars of fir, 2 inches broad by 1½ inch thick, placed 2½ inches apart. These spars should be put on both front and bottom.

5450. The *hay-racks* of the riding-horse stable should be of hardwood, and placed high up, with rails, 3 inches deep by 2½ inches wide, and turned rollers, 2 inches diameter, set 2½ inches apart. Cast-iron racks are frequently used in the corner of the stall, and they cost 15s. each.

5451. The *mangers* of the riding-horse stable should be of rounded battens in front, of full breadth of the stalls, placed at a convenient height above the floor, and bottomed and lined with 1½ inch deal. Cast-iron mangers cost 15s. each.

5452. In the work-horse stable, *corn-boxes* are placed in the near angle of the hay-racks.

5453. The *stalls* of the cow or feeding byres should be made of 1½ inch deal, beaded, grooved, and tongued. They should be 6 feet long, and 4 feet high, with 1 inch beaded coping, let into heel-posts, 5 inches to 6 inches diameter, and held to the wall at the head with a 2-inch fillet, and iron holdfasts on each side. The heel-posts should either be taken to the height of the byre-wall, and secured to runtrees, 6 inches deep by 2 inches broad, or fastened into the ground with masonry like those of the riding-horse stable, (5448.)

5454. The doors of the *feeding holes* of the byres should be of ¾-inch deal, of two thicknesses, crossed.

5455. The *stairs* from the corn-barn to the granaries, if of wood, should have 11 inches of tread and 6½ inches of height of steps. A stair or trap of similar dimensions may lead to the wool-room, from the straw-barn L, Plate II.

5456. The floors of the granaries, upper and corn barns, and wool-room, should have an angular *skirting* around them, of 3 inches by 3 inches.

5457. Should the upper barn, or granaries, or wool-room, be ascended by outside stone stairs, they should be furnished with plain ¾-inch iron *railing*, carried around the outer edge of the steps and platform, with a hardwood hand-rail, or be enclosed with ¾-inch deal lining the whole height above the steps, and properly framed.

5458. The interior of the *hen-house* should be fitted up with rough ¾-inch deal shelves and divisions, and roosting-trees 3 inches deep by 2 inches broad.

5459. The doors of the hen-house should be of 1½-inch deal, beaded, grooved, and tongued.

5460. *Wooden ventilators* should be placed upon the roof above every alternate pair of horses and cattle, on the stables and byres, of the form and dimensions of fig. 81; or they may consist of ¾-inch deal, 6 inches square, in an opening above every alternate stall, and furnished, on the upper part above the roof, with bent tubes of lead, 6 lb. to the square foot, or with zinc ones of the same dimensions. The zinc ventilators vary in price, according to size, from 4s. to 7s. each.

5461. The ceilings of the stables, boiling-house, granaries, where tile are used for roofing, wool-room, and hen-house, should be *lathed* with Baltic split-lath ⅞ of an inch in thickness. "Laths are sold by the bundle, which is generally called a hundred; but 7 score, or 140, are computed in the 100 for 3-foot laths; 6 score, or 120, in such as are 4 feet; and for those which are denominated 5 feet, the common 100, or 5 score."* Lath is also made of home wood, usually Scots fir, sawn up into ¾-inch plank, and split irregularly with the axe, and, when nailed on, the splits being kept open by means of a wedge; but this species of lath should never be used, as it does not stand.

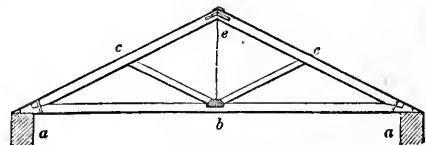
5462. The riding-horse stable should have *saddle-brackets* of ¾-inch deal, firmly supported, and two pins let into rails 6 inches wide, and 1½ inch thick, for each horse. The work-horse stable should have two similar rails, with large and small pins for each horse.

5463. Every court and hammel should be provided with a *gate*.

5464. The entrance to the *piggeries* should be furnished with doors of 1-inch deal, of two thicknesses, crossed, as in fig. 125.

5465. Since the introduction of railways, a style of roofing, capable of affording a great space in width at the stations, has been adopted for many purposes where room is required under one span of roof. This end has been effected by using the truss, upon which the scantlings are made to bear by means of screws. Fig. 439

Fig. 439.



A TRUSSED ROOF OF WOOD.

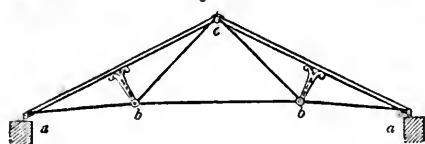
represents the section of a trussed roof in wood, where *a a* are the walls at the required distance; *b* is a beam of wood stretching across the void, and having a bearing of the breadth of the wall at each end; *c c* are couples held together at the upper ends by means of a clamp placed on each

* McCulloch's Dictionary of Commerce—art. Lath.

side, and screwed firm with bolt and nut, and their other ends are checked into the ends of the beam, and held down by iron straps. At the centre of the beam *b*, two trusses are placed against each other in a cast-iron socket at one end, and their other ends mortised into the centre of the couples at *c*. An iron rod, furnished with a head, is passed through a hole at the upper end of the couples at *e*, and its other end through a hole in the ends of the trusses, and the centre of the socket at *b*; and on this rod being screwed tight by means of a washer and nut, the beams, couples, trusses, and rod are braced so firmly together that the whole forms a rigid structure capable of resisting the downward pressure of the roof.

5466. The same end is attained by means of iron bars, rods, and cast-iron trusses. Fig. 440

Fig. 440.



A TRUSSED ROOF OF IRON.

represents the section of a roof constructed with these materials, where *a a* are the outside walls, *a c* are cast-iron flanged bars, serving as couples; malleable iron rods *a b*, *b a*, and *b c* are linked upon an end of the trusses at *b b*, which press at their other ends, spread outwards both ways to make a long bearing against the centre of the couples *a c*; the ends of the malleable rods pass through a cast-iron flanged bar at *c*; against which the ends of the couples rest, and are screwed up with a nut upon each—the effect of which is that the rods *a b* and *b b* are brought up above the level of the tops of the walls, and the couples, rods, and trusses are so braced as to form a rigid framing, fit to bear the weight of the roof.

5467. Such a species of roof is well adapted for certain parts of a steading. On a dairy farm, a large byre, capable of containing all the cows of the farm under the view of the dairymaid at one time; might be so roofed in. A byre truss-roofed with wood has been erected at the home-farm of Miss Edmonstoune Cranston, of Corehouse, near Lanark, which contains 48 cows, and its ground-plan is given in fig. 93, and again represented, in connexion with a steading for a dairy farm, in fig. 384. A feeding byre could be constructed on the same plan. The thrashing-mill and straw-barn might be contained under one such roof, affording abundance of room in its width to the water or steam power, to the cleaning of the corn in the barn, and to the straw chaff-cutter, and crushing-rollers, in the straw-barn. A roomy and airy granary could be formed under such a roof. Great accommodation could be afforded by means of such a roof to numbers of cattle all winter, and to sheep in the most stormy period of the winter on pastoral farms; and such an apartment would answer for dipping sheep in summer, and bathing them in autumn.

5468 In measuring carpenter and joiner work, the rafters and sarking are measured and priced by the superficial yard, and allowance is made of 13 inches by the length on peands and flanks. Balks are also measured and priced by the superficial yard. Wall-plates, ridge-rods, valley pieces, peand trees, lead fillets, &c., are measured and priced by the lineal foot, in addition to the rafters and sarkings. Bridlings for skylights, chimney tops, &c., are also taken in addition to the rafters. Joisting is measured and priced by the superficial yard—the length taken from the gables, and the breadth including the wall-holds. The wall-plates of joists are measured and priced by the lineal foot. The bridlings at the hearths are slumped. Flooring, deafening boards, and rounds, are measured and priced by the superficial yard. Bond timber, wall standards, and lath, are also measured by the superficial yard. Window sashes and cases are measured and priced by the superficial foot, and an allowance of 8 inches is made to the nett daylight width, and 2 inches to the height. Window fastenings, as soffets, breasts, elbows, and shutters, are measured and priced by the superficial foot; architraves, facings, and copes, by the lineal foot. The ironmongery connected with the joiner-work is estimated by the slump, and ought to be charged with the cost of putting on. Doors and their finishings are measured and priced in a similar manner to the windows, but no allowance is made in the height and width of doors. Skirtings are measured and priced by the lineal foot, and shelvings by the superficial foot; and the price should include the supports.

5469. All the varieties of *fir* timber imported into the country are employed in the building of steadings, and the kinds most used in localities are obtained from the nearest seaports. Along the east coast, Memel logs and Baltic battens are used for all such purposes; while on the west coast no timber is to be seen, in the construction of steadings, but the American.

5470. Norway and St Petersburg battens, being cut to proper lengths and breadths, form cheap and durable timber for all farm purposes. The price of the St Petersburg is, for red from 3d. to 3½d., for white from 2½d. to 3d. the lineal foot, and the Norway are a shade cheaper. Both red and white wood battens make excellent floors, and plain deal doors for inside use. Such flooring is beautifully dressed by the planing machinery at most of the principal seaports.

5471. Memel logs are admirably fitted for joisting, windows, outside doors, and all outside work, it being composed of strong and durable fibre, imbedded in resinous matter. It sells from 1s. 9d. to 2s. 3d. the cubic foot. The greatest objection to its use for small purposes is its knotiness, on which account the Norway battens make handier small scantlings and cleaner door-work.

5472. The American red pine is excellent timber, being clean, reedy, and resinous. Though

longer, it is seldom or never of so large dimensions as Memel log, and fetches from 1s. 8d. to 2s. the cubic foot. It is fitted for beams, joists, scantlings, windows, and outside doors.

5473. American yellow pine is well suited to all inside work, and especially that which requires the highest finish, such as bound-doors, window-fittings, and mantel-pieces. No wood receives paint so well. The logs are generally of immense sizes, affording great economy of timber in the cutting up. Its price is, for small sizes, 1s. 6d., and for large 1s. 10d. the cubic foot.

5474. Swedish 11-inch plank makes good and useful timber, but its scantlings are not very suitable for farm-buildings. I have seen stout joists for granaries made of it, with a $\frac{3}{4}$ -inch cleft taken off the side for sarking. It forms excellent planking for wheeling upon, and for gangways. It sells, the white wood from 5d. to 6d., and the red from 6d. to 7d. the lineal foot.

5475. In the interior of the country, at a distance from seaports, home timber is much used in farm-buildings. Larch forms excellent beams, but its scantlings and joists, though durable timber for rough work, are apt to warp. Well grown Scots fir of great age, and cut down in the proper season, if not as durable as the larch, forms good timber for rough purposes.

5476. All the timber I have referred to is derived from the trees belonging to the natural order of *Coniferae*, or cone-bearing trees. The Scots fir, *Pinus silvestris*, is a well-known tree in the forests of this country, and few new plantations are made without its aid, as a nurse for hardwood trees. In favourable situations it grows to a large size, as is evidenced in the Memel log, which is the produce of the Scots fir from the forests of Lithuania. I have seen Scots fir cut down at Ardovie, in Forfarshire, of as strong quality and large size as the best Memel, and much less knotty; and sold from 1s. 6d. to 2s. per cubic foot.

5477. The Swedish plank is of the spruce, *Abies excelsa* or *communis*—a tree which, as treated in this country, comes to little value, being rough and full of knots. Inspection of a cargo from Sweden, which arrived at Hull in 1808, convinced the late Mr Pontey that the white deal, which fetched at that time from L.14 to L.15, 10s. the load of 50 cubic feet, was of common spruce, the planks having been recently sawn, and a small branch left attached to one of them.*

5478. Whether the Norway pine is the same species as the pine in the forests of the north of Scotland, I do not know. I observe that some writers speak of the Norway batten as of the Norway spruce, called by them *Pinus Abies*. It

may be that the white wood battens are derived from that tree; but the red-wood kind has, probably, the same origin as the red-wood of the north of Scotland, which is a variety of the *Pinus silvestris*, the *horizontalis* of Don.†

5479. The red pine of Canada is the *Pinus resinosa*, and is a durable timber for all outdoor purposes, and for long logs requiring to span wide spaces.

5480. The yellow pine is the *Pinus variabilis* or *Pinus mitis* of Michaux, which towers in loftiness above all its compeers. It grows to the gigantic height of 150 feet, and must require great labour to square it to the sizes it is brought to the British market.

5481. The larch, *Larix Europæa*, is a native of the ravines of the Alps of the Tyrol and Switzerland, where it shoots up, as straight as a rush, to a height exceeding a hundred feet. The larch forests of Athole are extensive, and were calculated by their planter, the late Duke of Athole, to attain to a great size of timber, and return a large revenue after a given number of years.‡

5482. If woody matter be protected against the combined action of air and moisture, it may be preserved for an indefinite period; but if exposed to them, the case is very different. By degrees its hydrogen and oxygen are disengaged, and the carbon predominates more and more. Being formed of one atom of carbon, and one atom of water, as soon as woody matter is submitted to the action of a somewhat elevated temperature, without contact with air, it experiences an internal reaction, which tends to separate the atom of water from the atom of carbon. The water vaporises, and the carbon remains in the form of a black granular residue. The cells of woody matter contain different sorts of substances tending to organise, and these are mixed and modified in many different ways. In the want of ventilation, we thus see that timber must have a tendency to decay.

5483. Now, if any means could be devised by which the substances in the cells of woody matter could be deprived of their tendency to organise, when in contact with the air, timber might be rendered permanently durable. The solution of the corrosive sublimate of Mr Kyan, and that of the chloride of zinc of Sir William Burnett, have both a tendency to preserve the natural structure of the wood. The rationale of Mr Kyan's process is this:—The cells of wood, and particularly those of the albumum, contain the sap of the tree, which, in its circulation, reaches the leaves, where its watery particles fly off, and the enlarging matter of the tree, called the albumum, remains. Berzelius, as long ago as 1813, found that the addition of corrosive subli-

* Pontey's *Profitable Planter*, p. 41, 4th edition.

† *Quarterly Journal of Agriculture*, vol. xi. p. 530; and *Prize Essays of the Highland and Agricultural Society*, vol. xii. p. 122.

‡ *Prize Essays of the Highland and Agricultural Society*, vol. ix. p. 165.

mate (bichloride of mercury) to an albuminous solution produced calomel, (protochloride of mercury) which readily combined with the albumen, and produced an insoluble precipitate. This precipitate fills up all the cellular interstices of the wood, and becomes as hard as its fibres. I have not heard lately of either of those processes of preserving timber, so I suspect they have not fulfilled the expectations formed of them.

5484. It is from the Scots fir, *Pinus silvestris*, and spruce, *Abies excelsa*, that tar is obtained in the largest quantities. The tar of the north of Europe is of a much superior description to that of the United States, (4781.) It is obtained by a process of distillation, which consists of burning, in a smothering manner, roots and billets of fir timber, in a pit formed for the purpose on rising ground, and covered with turf. There is not much tar used on a farm; but as it is employed for many purposes, the implement-house should never want a barrel of tar. Tar is now imported duty-free.

5485. *Slater-work*.—Blue slates should be selected of large sizes, well squared, and have an overlap of two-thirds, gradually diminishing to the ridge, and be well bedded and shouldered with plaster-lime. The slates are fastened to the sarking with malleable iron nails, weighing 12 lb. per 1000, after being steeped when heated in linsed oil. These nails cost 3s. 4d. per 1000, 1300 being required for a roof of 36 square yards. Cast-iron nails were used until a few years ago, and they were also boiled in oil. The cost of blue slates in towns, including carriage, nails, and putting on, is L.4 per rood.

5486. Grey slates require lathing like tiles, but not being of a uniform size like tile, they are assorted in sizes in the quarry. The larger and heavier slates are put next the eave, and gradually diminish in size to the ridge, and the course at the eave is laid double, slate above slate. Every slate is hung upon the lath by a wooden pin passed through a hole at its upper end, and the slates are overlapped at least one-third. Grey slates should be bedded and shouldered either in plaster-lime or on moss, the latter making the warmer roof. As grey slates are not adapted for pavilion roofs, the peands should be covered with lead or zinc, but the safest form of grey slating is with upright gables. The ridge is covered with freestone ridging-stone, which cost 1s. per lineal foot. In Forfarshire, grey slates cost L.4 per 1000, 360 being sufficient for a roof of 36 square yards. The putting on, dressing, holing, pins, and nails, cost 15s.; moss 1s., and lime 3s.; in all, 19s. per rood.

5487. Pan-tiles are laid on lath $1\frac{1}{4}$ inch square, to a gauge of 10 or 11 inches; and 576 will cover a roof of 36 square yards. The overlap should be 3 inches; bedded and shouldered, and the under joints pointed with plaster lime. There should be 3 or 4 course of slates along all the eaves, and the flanks, peands, and ridges, are covered with tile. The cost of putting on, pins, and lime, is 56s. per rood. Un-

less tiles are smooth on the surface, compact and ring freely when struck, they are porous, and will imbibe moisture in winter, and decay by the effects of frost. The duty on the manufacture of house tiles was removed in 1846.

5488. Of all these methods of covering a roof, slating with blue slates has the best appearance, is the most comfortable, most substantial, and even most economical in the long run. Tile roofs, on the contrary, are constantly requiring repairs, and are most expensive in the long run. Grey slates, being always heavy, incur a great sacrifice of timber in the roof.

5489. Blue slate is derived from the primitive clay slate, and, when compact, does not absorb moisture, but when not so, soon becomes covered with moss and decays. The principal quarries are in Wales, Lancashire, Westmoreland, Cumberland, Argyle, and Perthshire. The Welsh slate of Caernarvonshire is smooth, and often large; and when thin, is apt to warp in the changes of temperature. The English slates are not so large as the Welsh, but equally good. The Argyle Easdale slates are small, heavy, very hard, waved, containing cubes of iron pyrites, and their durability is endless; and the Ballalulish, though also small, are smoother and lighter, containing cube pyrites, and equally durable. The Perthshire slates are inferior.

5490. Blue slates are assorted in sizes at the quarry. The sizes at Bangor, in Wales, vary from 36 inches in length to $5\frac{1}{4}$ inches in breadth. The weight varies from 82 cwt. to 12 cwt. per 1000.

5491. Grey slates are derived from the inferior grey sandstone of the old red sandstone series. The finest quarries of them are at Carmylie, in Forfarshire, belonging to Lord Panmure. The Arbroath pavement, as it is called, is from the same rock; and on being set on edge in winter, when taken out of the quarry, the frost causes it to split into slates; so that when little frost occurs in winter, the output of slates is limited.

5492. The *pitch* of a roof varies with the sort of slating. In blue slating the rule is, to have the height of the roof one-third of the breadth of the building, outside measure; and when large Welsh slates are employed, the pitch is reduced to one-fourth. Old-fashioned houses have a pitch of the square; that is, the height is equal to half the breadth of the building. In grey slating it is fixed at about one foot below the square. In tiling, the pitch may be lower than even in blue slating, and is determined according to circumstances. Taking the rise at 7 feet, on a breadth of 18 feet inside, the scantlings should be 13 feet long each, and the balk as long, on walls 2 feet thick. Taking the rise at 9 $\frac{1}{2}$ feet, the scantlings should be 14 feet long.

5493. *Slater-work* is measured and priced by the roof of 36 square yards, and tile work in a similar manner. Ridge and peand tiles are

measured and priced by the lineal foot. In pointing skews with mastic or Roman cement, the measurement and price are by the lineal foot. An allowance on slater-work of 9 inches is made at all the eaves, and 18 inches on peands and flanks, and 3 inches at the skews.

5494. *Plumber-work.*—The flanks should be covered with sheet lead, 18 inches broad, weighing 7 lb. per square foot, the peands with 6-lb. lead, 15 inches broad. The ridges should be covered either with droved angular freestone ridge-stones, or with 6-lb. lead, 15 inches broad, supported on 2½ inches in diameter of ridge-rolls of wood. Platforms and gutters should have 8-lb. lead per square foot. In cisterns lead should be 8 lb. in the bottom, and 7 lb. in the sides and ends, per square foot. Rain water-spouts of 4½ inches in breadth, and conductors of 2½ or 3 inches in diameter, should be of 6-lb. lead per square foot.

5495. Sheet zinc has been substituted of late years for lead, but with no advantage in use or workmanship; but the cost is about one-third. The zinc put on flanks should weigh 22 oz., and costs 6½d. per square foot. The peands have 15-inch sheet zinc, weighing 22 oz., and costing 6½d. per square foot. The zinc covers for peands and ridges are so prepared that they clasp by contraction, and thereby hold on by the wooden ridge-rolls. Zinc is not suitable for gutters and valleys.

5496. Rain-water spouts, or *rones* as they are commonly termed, may be made of wood, cast-iron, lead, or zinc. Wooden ones may be made out of the solid, or in slips nailed together. When made out of the solid, with iron holdfasts, they cost 1s; and when pieced together, 6d. the lineal foot. The conductors from both kinds cost 8d. the lineal foot. Wooden spouts should be pitched inside and painted outside. Cast-iron ones are heavy, and they cost 1s. 9d. per foot if of 4½ inches diameter; and the conductors, of from 2 to 4 inches diameter, from 9s. to 17s., of 9 feet in length each. Lead makes the best spout, but is expensive, being 1s. 6d. a foot. Zinc ones, on the other hand, are very light. Stout 4-inch zinc spouts cost 7d. the foot; and a 2½ pipe, as conductor, 6d. the foot. The lowest part of the pipe-conduit should, in all cases, be made of cast-iron, to ward off accidents. Every sort of water-spout should be cleaned out at least once a-year, and wooden ones should have a coat of paint annually.

5497. The lead of commerce is derived from the ore galena, which is a sulphuret of lead—yielding 87 per cent of lead, and 13 per cent of sulphur. Galena is found in the largest quantities in the transition limestone. The galena lead mines of Derbyshire, Durham, Cumberland, and Yorkshire, are situate in limestone; while those at Leadhills, in Scotland, are in greywacke. Great Britain produces the largest quantity of lead of any country in the world.

5498. Zinc is derived in the largest quantities

from a sulphuret named blende, and a carbonate named calamine, in the mountain and magnesian limestones. The most malleable zinc is derived from Upper Silesia, under the name of spelter; and is sent to Hamburg and Belgium to be shipped for this country.

5499. In measuring plumber-work, the lead on roofs is by the superficial foot, and the price is according to the weight per foot. Where a variety of prices occur, they should be slumped in common, and charged per cwt. In ordinary cases, 3s. per cwt. for putting on is a fair price. Conductors, and pipes of every description, are measured by the lineal foot, and priced according to weight. Zinc on roofs is measured by the superficial foot, and priced according to weight. Rones are measured by the lineal foot. Brass-work is priced by the slump.

5500. *Plaster-work.*—The plaster-work of a steading, not requiring to be ornamental, should be simple. The ceilings of the riding-horse stable, boiling-house, wool-room, and hen-house, when tile-roofing is employed, should be finished with two coats of the best haired plaster, hard rubbed in. The walls of the granaries, corn-barn, work-horse stable, cow-byre, boiling-house, calves'-house, wool-room, gig-house, and hen-house, should be finished with one coat, hard rubbed in. The walls of the riding-horse stable should have three coats, hard rubbed in. Plaster-work is measured by the square yard, and costs for one coat 3d., for two coats from 4d. to 4½d., and for three coats from 5d. to 6d., the square yard. Cornices are measured and priced per lineal foot. Pit sand should be used in making plaster, the alkaline matter of the sea sand injuring the surface of the plaster even after it is dry, unless the sand has been thoroughly washed in fresh water. At the same time, when sea-sand has been thoroughly and carefully washed, it makes the best work. Drift-sand, above sea-water mark, is the best sort of sand, but must be thoroughly washed in fresh water.

5501. *Smith-work.*—All the outside doors, including those on the feeding-holes at the byre, should be hung with crooks and bands. The crooks should be fastened into the ingoings of the ribats with melted lead. The larger crooks and bands cost 10s., and the smaller 5s., per pair, according to weight. The inside doors should be hung with T hinges, 18 inches long, and the opening parts of the windows with 9-inch T hinges. The former are 1s. and the latter 9d. a pair. The outside doors should have good 10-inch stock-and-plate locks, which cost 5s. each, except where there are more than one outside door to the same apartment, in which case all the doors but one can be fastened by bars from the inside. The inside doors should have the same sort of locks; the common stock-locks are not worth the money. Thumb-latches are convenient for opening and keeping shut doors that do not require to be constantly locked, such as of the corn-barn, granary, boiling-house, cow-byre, and hen-house. These latches cost from 1s. to 1s. 6d. each. A wooden bar of hard-

wood, to open and shut from both sides, is a convenient mode of fastening inside doors. The upper-barn door, of two vertical leaves, requires an iron stay-band to fasten it. The doors of the riding-horse and work-horse stables should be provided with sunk flush ring-handles and thumb-latches, to be out of the way of catching any part of the harness. The mangers of the riding-horse stable, and the upper rail of the hay-rack of the work-horse stable, should be provided with rings and staples for the stall-collar-shafts to pass through. These cost 3d. each.

5502. Various descriptions of *nails* are used for the different parts of work in a steading. The scantlings of the roofs are fastened together with *double-doubles*, which cost 5s. per 1000. Deals of floors are fastened down with flooring nails 16 lb. weight, and 4s. 6d. per 1000. The bars of the plain-deal doors are put on with 10-lb. nails, which cost 3s. 6d. per 1000. For finishing, *single-flooring* nails at 2s. 6d., and 2-inch sprigs at 2s. to 2s. 3d. per 1000 are used.

5503. As a security against burglary, iron stanchions, seven-eighths in diameter, should be fixed on the outside of the windows of the corn-barn, implement-house, and hen-house. Such stanchions cost 3d. per pound.

5504. Iron is found, in this country, in the coal formation. It occurs in alternate beds with coal and sandstone. It occurs chiefly in two states—that of sulphuret, clay over stone, and of carbonate, black-band. Since the discovery of the black-band and the hot-blast, the smelting of iron has been much facilitated, and its quantity in the market greatly increased. Cast-iron usually costs from 8s. to 10s. per cwt.

5505. *Glazier-work*.—The windows of all the apartments should be glazed with best second crown glass, fastened with fine putty. It costs 6d. per superficial foot. The panes in the windows of a steading should not be large, both on account of the smaller cost of a small pane, and of the additional security afforded against intrusion by numerous astragals. So great a change has taken place in the use of glass since the removal of the duty in 1846, that the kind best fitted for a steading has, perhaps, not yet been determined; but this I may say, that glass being now so cheap, the best and strongest should be used for all purposes. Rough plate-glass is so thick and strong that it may be extensively employed in the roof, for affording light to apartments, instead of windows. It costs 1s. per superficial foot. Russell's patent glass tiles cost 8s. per square yard.

5506. A *skylight* in blue slating is made of a frame fastened to the sarking. In tile-roofing, tiles are made on purpose to hold a pane of glass. In grey-slating, a hole is made in the slate to suit the size of the pane. A dead skylight of zinc, to answer every kind of roofing, costs 4s. Pan tiles of glass cost about 1s. 6d. each.

5507. *Painter-work*.—The outsides of all the

outside doors and windows, all the gates of the courts and hammels, and the water-troughs in the various courts, if made of wood, should receive *three coats of good paint*. Painting costs 3d. or 4d. the square yard, but three coats can be done for 8d. the square yard. The best standing colours, and they happen to be the cheapest too, are grey, s:one, or slate-blue: the last seems to be most commonly preferred, though the stone colour is the most cheerful. Green is dear, and soon fades; and red is distasteful in buildings. White-lead and oil are the principle ingredients in paint, and no colouring matter has power to preserve timber from the effects of the weather.

5508. A substance called *lithic paint* has recently been found to answer well for country purposes. The lithic, which costs 2½d. per lb., is ground to powder, and mixed in a certain proportion with cold coal-tar, and the mixture is applied with a brush. It deprives the coal-tar of its noxious smell, and hardens it into a durable paint in a few days. Such a substance may answer for painting articles at a distance, such as field-gates, sluices, and the like; but it is not agreeable to use at the steading. The painting of doors and windows, and other things, is very much neglected about a steading.

5509. White-lead of commerce is a *carbonate of lead*, or *ceruse*, artificially formed from pure lead. It has long been made at Klagenfurth, in Carinthia, and large quantities are also manufactured in England. Its composition is 1 equivalent of lead, 1 of oxygen, and 1 of carbonic acid; or by analysis, of lead 77.6, oxygen 6, and carbonic acid 16.4.

5510. These specifications are followed by the measurements of the different species of work required to execute such a steading as is represented in Plates I. and II. I should mention that the prices of the respective works are put down at those usually charged in Edinburgh for similar work, and that the carriage of all the materials used is included.

5511. MASON-WORK.

Roods.	Yards.	Feet.	Inches.		
10	3302	14		Cubic, of digging at 6d.,	£82 11 3
				Superficial, rubble in foundations, reduced to 2 feet thick, at 25s.,	126 7 0
82	23			Superficial, rubble building in walls, 2 feet thick, at 18s.,	743 15 0
43	21	4		Superficial, rubble in walls 1 foot thick, at 100s.,	217 19 6
		100		Lineal, chimneys at 4d.,	1 13 4
		1668		Lineal, drains leading to the manure tank, at 1s. 6d.,	80 2 0
		2297		Lineal, drains round the buildings, at 1d.,	9 11 5
		35		Lineal, pillars for cart shed, 2 feet by 2 feet, at 6s.,	10 10 0
		72		Lineal, segmental ring pens for the arches of the cart shed, at 2s.,	7 4 0
		11		Lineal, corner on one end of the cart shed, at 2s.,	1 2 0

Carry forward, £1280 15 6

Roods.	Yards.	Feet.	Inches.		Roods	Yards.	Feet.	Inches.	
				Brought forward,					Brought forward,
14				Lineal, pillars for the calves' shed, 1 foot 6 inches by 1 foot 6 inches, at 4s. 6d.,					3 pairs chimney jambs with lintels, hearths, and shelves, at 30s.,
				3 3 0					4 10 0
16				Lineal, corners for gig-house, with giblet checks, at 2s. 6d.,					2 boilers for boiling houses, with furnace doors, branders, &c., at 60s.,
				2 0 0					6 0 0
10				Lineal, segmental arches with giblet check, at 2s. 6d.,					Building in the two boilers, at 42s.,
				1 5 0					4 4 0
652				Lineal, ribs for doors and windows, at 2s.,					28 club skewers for gables, at 2s. 6d.,
				65 4 0					3 10 0
510				Lineal, sills and lintels for doors and windows, at 2s.,					28 stones for heel and fore posts in the stables, at 5s. 6d.,
				51 0 0					7 14 0
176				Lineal, corners for the openings to the hammels, at 2s.,					18 stones for heel-posts in the byres, at 5s. 6d.,
				17 12 0					4 19 0
64				Lineal, pillars between the openings, at 2s. 6d.,					20 stones for stakes in the byres, at 5s. 6d.,
				8 0 0					5 10 0
114				Lineal, segmental arches over the openings, at 2s.,					32 malleable iron gratings for drains in the courts, at 5s.,
				11 8 0					8 0 0
231				Lineal, corners of the gates in the walls of the hammels, at 2s.,					32 stones for the gratings, at 6s. 6d.,
				23 2 0					10 8 0
36				Lineal, pillars between the gates, at 2s. 6d.,					5 stone troughs in the courts, at 42s.,
				4 10 0					10 10 0
107				Lineal, steps in doors, at 1s. 6d.,					Allow for jobbing, for other tradesmen, &c.,
				8 0 6					10 10 0
70				Lineal, corners of gates in low walls, at 3s. 6d.,					Lineal, corners of building, at 2s.,
				12 5 0					32 14 0
112				Lineal, corners, sills, and lintels of feeding holes in the byre, at 2s.,					
				11 4 0					
90				Lineal, hammer-dressed ribs, sills, and lintels for narrow apertures in the barns, at 1s. 6d.,					Amount of mason work,
				6 15 0					£1883 8 8
36				Lineal, corners of chimney stalks, at 2s.,					
				3 12 0	5512.				
30				Lineal, coping of chimney stalks, at 1s.,					
				1 10 0					
316				Lineal, of skewes on the gables, 14" by 3", at 1s. 6d.,					
				23 14 0					
200				Lineal, of coping on walls for sloping roofs, at 2s. 3d.,					
				22 10 0					
991 6				Lineal, of semicircular coping on the tops of the low walls, at 1s.,					
				49 11 6	2857				
5				Lineal, pillar in pigs' court, 1 foot 6 inches by 1 foot 6 inches, at 4s. 6d.,					
				1 2 6					
360				Superficial, pavement on floors of engine-house, &c., at 9d.,					
				13 10 0	1803				
738 6				Superficial, of pavement in riding-horse stable and gig-house, grooved, at 10d.,					
				30 15 5	1114				
37				Lineal, of channel in riding-horse stable, labour only, at 3d.,					
				0 9 3					
144				Lineal, stone sills for the divisions of the byres, at 2s.,					
				14 8 0	2438				
111				Lineal, of grupe in the byres at 2s.,					
				11 2 0					
1 28 6				Superficial, rubble in the walls of gangway, 2 feet thick, at 180s.,					
				16 3 4	944				
5 6				Superficial, rubble on the foundations, reduced to 2 feet thick, at 7s.,					
				1 19 8	96				
28				Superficial, hammer-dressed arch for the gangway, reduced to 1 foot thick, at 3s. 6d.,					
				4 18 0	22				
16				Lineal, corners for the gangway, at 2s.,					
				1 12 0	631				
24				Lineal, ring pens for the arch of the gangway, at 2s.,					
				2 8 0					
26 34 3				Superficial, causeway in the byres, calves'-house, boiling-houses, out-houses, turnip-stores, hay-house, work-horse stable, passages, &c., at 54s.,					
				72 15 6	90				
106				Lineal, drained gutter stones in work-horse stable, 14" by 7", at 2s.,					
				10 12 0	666				
50				Lineal, stalk of engine-house, tapered, base 6 feet square, at 15s.,					
				37 10 0	24				
25				Lineal, base for the pedestals of the engine stalk, at 2s. 6d.,					
				3 2 6	361				
20				Lineal, droved plinth on the top of the engine stalk, at 3s. 6d.,					
				3 10 0	140				
16				Lineal, droved blocking for the engine stalk, at 2s. 6d.,					
				2 0 0	54 8				
				Carry forward,					Carry forward,
				£1774 19 8					£1095 5 3

Roods.	Yards.	Feet.	Inches.		Roods.	Yards.	Feet.	Inches.	
				Brought forward, £1095 5 3					Brought forward, £1374 16 0
273	2			Superficial, of windows for byres, at 2s.,	27	6	0		granaries, corn-barn, &c., at 6d.,
260				Superficial, of windows for granaries, at 2s.,	26	0	0	679	Lineal, of feeding-troughs in courts and hammels, including bed of rubble, as 2s.,
1123	6			Superficial, of 1½ inch, plain deal doors, grooved, tongued, and beaded, at 6d.,	23	1	9	36	Lineal, straw-racks in sheds under granaries, at 1s.,
346	6			Superficial, of 1 inch thick, plain deal doors in barns, stables, &c. at 5d.,	7	4	4	7	luffer board ventilators on tops of roofs, at 21s.,
64				Superficial, of 1½ inch, plain deal doors to gig-house, with framed styles, rails, &c., in 2 leaves, at 1s.,	3	4	0	2	wooden trap-stairs to granaries, &c., each about 18 feet long, with lining,
731				Lineal, door standards, 6½ inches by 2½ inches, at 5d.,	15	4	7	1	wooden trap-stair to wool-room, 18 feet long, with hand-rail on one side, at 63s.,
440				Lineal, door facings, at 3d.,	5	10	0	5	5-barred gates, with diagonals, each 9 feet by 5 feet high, for courts, at 40s.,
516				Lineal, door keps, at 3d.,	6	9	0	1	5-barred gate, 8 feet wide, and 5 feet high,
214	6			Lineal, lining for ingoes of doors, 12 inches broad, at 5d.,	4	9	4	20	5-barred gates to small courts, 4 feet wide and 5 feet high, at 20s.,
719				Lineal, corner beads for windows, &c., at 3d.,	8	19	9	8	strong wooden sliding-bars for part of doors, at 2s.,
48				Superficial, of plain deal doors to feeding holes, in 2 thicknesses doubled across, at 9d.,	1	16	0	1	hardwood swivel-bar, with iron mounting for gig-house,
117				Superficial, 1½ inch travis boarding in riding-horse stable, dowelled, at 8d.,	3	18	0	1	large corn-bin in hay-house, with padlocks, hinges, &c.,
117				Superficial, 1½ inch, beaded deal lining on end walls of riding-horse stable, on fixtures, at 6d.,	2	18	6	1	corn-conductor to do., from granary above,
350	2			Superficial, ¾ inch thick, beaded lining on walls on fixtures, at 4d.,	5	16	8	1	small corn-bin, fitted up in window of riding-horse stable, with padlock, &c.,
68				Lineal, 1 inch, beaded coping on top of lining, at 3d.,	0	17	0	3	saddle-brackets with pins, &c., at 7s. 6d.,
663				Superficial, 1½ inch deal travis boarding in work-horse stable, at 7d.,	19	6	9	14	small mangers fitted up in work-house stable, at 3s. 6d.,
237	9			Superficial, 1½ inch beaded lining on end walls, &c., on grounds, at 6d.,	5	18	10	30	strong pins for harness in work-house stable, at 6d.,
886	6			Superficial, ¾ inch narrow beaded lining on walls on fixtures, at 4d.,	14	15	6	24	iron hooks for work-horse stable at 6d.,
220				Lineal, 1 inch beaded coping on lining, at 3d.,	2	15	0	2	turned heel-posts for riding-horse stable, at 18s. 6d.,
156				Lineal, beaded heel-posts of stables, 6 inches by 6 inches, at 1s. 6d.,	11	14	0	2	turned half heel-posts in riding-horse stable, next the walls, at 7s. 6d.,
156				Lineal, beaded fore-posts in 2 pieces bolted together, at 1s.,	7	16	0	18	heel-posts for byres, each 4 feet 6 inches long, at 6s.,
143				Lineal, top-rails for steadying heel-posts, &c., 6½ inches by 2½ inches, beaded, &c., at 9d.,	5	7	3	4	half heel-posts for end walls, same length, at 4s. 6d.,
144				Lineal, of spars over the top of top-rails, at 3d.,	1	16	0	20	pieces of wood for bending top of the stakes to the wall, at 1s.,
45				Lineal, angular pieces for heads of divisions of riding-horse stable, at 3d.,	0	11	3		Fitting up 20 small manger and hay racks for calves' cribs, at 5s.,
54				Lineal, rails for pins in work-horse stable, at 6d.,	1	7	0		Fitting up the interior of the dovecot,
84				Lineal, hay-racks in work-horse stable, price to include the seed-tracks at the bottom, at 1s. 6d.,	6	6	0		Fitting up the interior of the hen-house,
576				Superficial, 1½ beaded deal divisions of byres, at 6d.,	14	8	0		Fitting up the interior of the hatching-houses,
153				Lineal, of strong top-rails for divisions, with grooves, at 6d.,	3	16	6		2 straw racks in large courts, at 30s.,
123				Superficial, 1½ inch lining on end walls on grounds, at 6d.,	3	4	0		6 pair strong crook-and-band hinges for the gates of courts, at 10s.,
34				Lineal, of top-rail for lining at 6d.,	0	17	0		6 strong fasteners for the gates, at 2s. 6d.,
95				Lineal, of feeding-troughs for byres, at 1s. 6d.,	7	2	6		20 pair crook-and-band hinges for the gates of the small courts, at 5s.,
200				Lineal, of hard wood stakes for do., at 6d.,	5	0	0		26 fasteners for the gates, at 1s.,
758				Superficial, of spar divisions for calves' cribs, including doors and framings, supporting them, at 6d.,	19	14	0		6 stock locks for doors to hatching-houses, &c., at 5s.,
910	6			Lineal, skirting on grounds for					6 pair crook-and-band hinges for the hatching-houses, at 1s. 6d.,
				Carry forward, £1374 16 0					38 stock and plate locks for all the other outer doors, &c., at 5s.,
									38 thumb latches for these doors, at 1s.,
									Carry forward, £1590 18 9

Boards.	Yards.	Feet.	Inches.		
				Brought forward,	£1590 18 9
				46 pair strong crook-and-band hinges for these doors, at 2s. 6d.	5 15 0
				2 pair strong crook-and-band hinges for gig-house doors, at 10s.	1 0 0
				12 pair crook-and-band hinges for the doors of the feeding holes, at 3s. 6d.	2 2 0
				12 iron fasteners for these doors, at 1s. 6d.	0 18 0
				3 cast-iron hay racks for riding-horse stable, at 15s.	2 5 0
				3 cast-iron mangers for riding-horse stable, at 15s.	2 5 0
				18 manger rings, at 3d.	0 4 6
				6 rings, heel posts, in the riding-horse stable, at 3d.	0 1 6
				20 seals for byres, at 2s. 6d.	2 10 0
				Jobbing for the other tradesmen, furnishing masons' sheds, scaffolding, &c.	15 0 0
				Amount of carpenter work,	£1620 19 9

5513.	SLATER WORK.				
87 19	Superficial slating, at 80s.	£350	2 2		

5514.	PLUMBER WORK.				
1735	Superficial, of 6-lb. lead on ridges, peards, flanks, flashings, and tops of ventilators, at 1s. 3d.	112	3 9		
1943	Lineal, of 5 inches, water rones on eaves of roofs of 7 lb. lead, supported by iron straps, 2 feet apart, at 1s. 6d.	145	14 6		
288	Lineal, of 3 inches, rain pipes of 6-lb. lead, supported with iron holdfasts, at 1s. 6d.	21	12 0		
	1 pump well, with pipes, &c., for supplying the different water-troughs,	5	0 0		
370	Lineal, supply pipes from the pump to the different troughs, at 8d.	12	6 8		
	7 brass sockets for the troughs, at 2s. 6d.	0	17 6		
	Amount of plumber work,	£297	14 5		

5515.	PLASTER WORK.				
534 6	Superficial, of 3-coat plaster in gig-house, riding-horse stable, boiling-houses, and wool-room, at 6d.	13	7 4		
815 3 8	Superficial, of 1 coat on the walls of the byres, calves'-house, granaries, hay-house, work-horse stable, &c., at 3d.	10	3 10		
	Amount of plaster work,	£23	11 2		

5516. The expense of building a steading of these dimensions and specifications must be considerable anywhere, and particularly so if the prices of work, materials, and carriage, are taken at the rate usual in large towns. It will amount as follows:—

Mason work	£1883	8 8
Carpenter work	1620	19 9
Slater work	350	2 2
Plumber work	297	14 5
Plaster work	23	11 2
	£4175	16 2

5517. Now as steadings are generally executed by tradesmen resident in the country, the difference of wages will have to be deducted from the above sum, which generally amounts to 10 per cent, and that deduction from £4175, 16s. 2d. will amount to £417. Carriages, also, are commonly supplied by the tenant who is to occupy the steading; and in the above case, at the rates in town, these will amount to about £1500. The timber in the above estimates is supposed to consist of the best foreign; and should a proprietor supply good home timber instead, the cost will be reduced accordingly: but what the amount of the reduction will be, will depend upon various circumstances. The plumber work is estimated in the best lead; but zinc is coming into use, and is much cheaper at first, although not nearly so good for any purpose. If zinc be employed, the difference of the cost will have to be deducted. There should be much more plaster-work in steadings than is commonly to be found, it being both healthy and cleanly. Taking such of the deductions as can be estimated in money at once, the cost will stand thus:—

The above amount is	£4175	16 2
Deduct country wages	£417	0 0
... town carriages	1500	0 0
... home timber	...	...
... zinc	...	...
Making the cost	£2258	16 2

£2250 is no inordinate sum for a landlord to pay for such a steading with the best foreign timber; and finished in every respect in the most complete manner.

ON THE FARM-HOUSE.

5518. It is not my intention to say anything here on the construction of the farm-house, as I have already expressed my opinion of the arrangement which the working part of the house should assume, to be convenient for the work to be done, and as far separated from the part of the house occupied by the farmer's family, as to avoid disturbance to them. In fig. 362 is represented the ground-plan of the back jamb of the house, in which is situate the kitchen *a*, the scullery *d*, the kitchen pantry *k*, and the milk-house *m*, and a lock-up closet *c* for containing articles in daily use in the cookery. By ascending the stair *k* in fig. 363, the story above is reached, in which is the cheese-room *h*, a store-room *d*, two bed-closets for servants *a* and *b*, a water-closet *i*, and a stair to the garret *l*.

5519. In connection with the farm-house is the subject of *locks*. It is very poor economy to use ill-made locks in any

apartment of a farm-house, and especially in those which contain articles which are usually locked up. In all those places—as the store-room, linen presses, and all wall-presses—the best species of lock should be used, as such locks are not only pleasant to use, but cannot go wrong, and are impossible to be opened but with the proper key: The outside door of a farm-house is commonly provided with a very common spring-lock, which is always ready to be opened but when the key is turned in it, leaving the house in that quarter constantly accessible during the day, and part of the evening. Now such a door should be provided with one of Chubb's patent locks, which has not only a small key, but is easily opened as a check-lock; is beyond the power of any one to pick; when attempted to be picked, tells it has been so; cannot go wrong; lasts a lifetime without repairs, and affords unspeakable security. One peculiarity of this lock is, that it has a number of bolts, every one of which must be lifted before the door will open, each bolt being a security equal to any common lock. Another peculiarity is its detector, by which any attempt to pick or open the lock by a false key is immediately notified on the next application of the proper key, which will not open the lock. It, however, makes the lock again serviceable by being turned the wrong way, which no false key is capable of doing. The lock has commonly six bolts, or tumblers, and a detector; and the ordinary chances against any key but its own opening it is 720. But the height of the shortest step in the key is capable of being altered twenty times, so that the chances against opening the lock may be increased to 14,400: each of the six steps can be as many times altered, so that the chances may be increased to 86,400. The detector can be altered ten times, so the chances are increased to 864,000. Further still, the drill-pins of the locks, and the pipes of the keys, may be easily made of three different sizes, so that the number of chances may be increased to 2,592,000. In still larger locks, the chances may be increased to 7,776,000. The corn-barn, granaries, meal-chest, hen-house, and implement house, ought all to be protected with such locks. I do not suppose that

farm-servants are more dishonest than other persons of their class, but we all know that to put temptation in the way of a man who has hitherto borne a good character may be the means of corrupting his honesty; and besides, when people are made aware that the more precious things are *really secured* with superior locks, the desire to attempt to obtain them, through the locks, will soon subside.

5520. The properties of a good lock are strength of materials, simplicity of construction, durability of action, good workmanship, and perfect security. Without one and all of these properties, a lock is worthless; and Chubb's locks possess them all in an eminent degree. With such qualifications, the price cannot be low, but it is cheap in the long-run.* I have used one with six tumblers for several years in the outer door as a check-lock, which cost me 15s. with two keys.

5521. As a good supply of water is an essential comfort to every farmhouse, I shall describe the sinking of a well, and the construction of a useful rain-water cistern. Of so much importance is one good well on a farm, that a considerable expense should be incurred rather than want, at any season, so necessary a beverage as water to man and beast. In trap and other amorphous rocks, little water may be expected to be found, and the labour of sinking by blasting with gunpowder renders a well sunk in those substances a very expensive undertaking. When there is probability of finding water in stratified rocks under trap, the latter may be penetrated by boring with a jumper, with the view of forming an Artesian well; but before such a project is undertaken, it should be ascertained beforehand that stratified rock or diluvium exists below the trap, and that the dip of either is towards the site of the well. When insuperable obstacles exist against finding water on the spot, perhaps the better plan will be either to go a distance to a higher elevation, where a common well may succeed in finding water, and then convey it to the steading, by means of earthenware, iron or lead pipe; or to descend to a lower site and throw the water up to the steading by means of a water ram, (111.) Either of these plans may be less expensive, or more practicable, than boring through a hard rock to a great depth. The well in Bamborough Castle, in Northumberland, was sunk upwards of 100 feet through trap to the sandstone below; and at Dundee, a bore was made through trap, 300 feet, to the inferior sandstone below, by means of its steam-engine, to obtain water for a spinning-mill.

5522. In gravel and sand, a well may be

* Chubb *On the Construction of Locks*, p. 15.

sunk to a considerable depth before finding water. Being desirous of a supply of water to three adjoining fields of dry turnip land, resting on a deep bed of pure gravel, and which had no watering pool, I fixed on the most likely spot to contain water, near the foot of a rising ground of diluvial clay, in which to dig a well, and it happened to be a spot common to all the fields. After persevering to the depth of 22 feet without success, at the imminent hazard of burying the men in the gravel, as a despairing effort, at night-fall, I caused a foot-pick to be thrust down into the bottom of the pit as far as the handle, and on withdrawing the instrument water was seen to follow it. Next morning 3 feet more were dug; and, the water excavating the gravel around the bottom of the pit, rendering further digging a dangerous operation for the men, the ring of the well was built with stones. The water rose no higher in the well than 3 feet, but the supply was sufficient for the use of three fields. On finding water in this case, in the midst of rather hopeless symptoms, I would recommend perseverance to diggers of wells.

5523. In very unctuous clay, such as is found in earse land, water is difficult to be obtained by digging to ordinary depths; but as such a country is usually situate near a large river, or on the side of a broad estuary, by digging to the depth of the bed of the river, some sand will most probably be found through which the water will find its way to the well; and though brackish in the estuary, it will probably come into the well sweet enough for all domestic purposes.

5524. Wells dug in stratified rocks, such as sandstone, may be supplied with water at the moderate depth of perhaps six or eight feet; but amongst regular strata as much risk exists of losing water as in obtaining it. To avoid disappointment, it will be necessary to puddle the seams of the rock on that side of the well in which it dips downwards.

5525. The substance which most certainly supplies water on being dug into is diluvial clay, a substance that forms the subsoil of the greatest extent of the arable land of this kingdom. This clay is of itself impervious to water, but it is always intersected with small veins of sand frequently containing mica, and interspersed with numerous small stones, on removing which water is found to ooze from their sites, and collect in any pit that is formed in the clay to receive it. The depth to be dug to secure a sufficiency of water may not be great—perhaps not less than eight feet, or more than sixteen feet; but when the clay is homogeneous and hard, and there is little appearance of water, digging to upwards of 40 feet in depth will be required to find water. I knew a remarkable instance of a well that was dug in such clay in Ireland, in which 40 feet were penetrated before any water was found; but immediately beyond that depth, so large a body of pure water was found in a small vein of sand, that the diggers escaped with difficulty out of the well, leaving their tools behind. A force-pump was obtained to clear the well of

water, in order to allow the ring to be built; but it was unable to reduce the bulk of water, so that the ring remains unbuilt to this day. The water always stands within three feet of the top of the well, and the clay is not much affected by it.

5526. Suppose, then, that the well is to be dug in clay, containing small stones and veins of sand. Let a circle of eight feet in diameter be described on the surface of the ground, from whose area let the surface-soil be removed to be used elsewhere as compost. After throwing out a depth of eight or nine feet with the spade, let a winch and rope and bucket be set up to draw the earth out of the well. While the digging is proceeding, let a sufficient quantity of flat stones be laid down near the winch, by which to let them down to build the ring. A depth of sixteen feet will most probably suffice; but if no water is found, let the digging proceed to the requisite depth. A ring of three feet in diameter will be a large enough bore for the well: the rest of the space should be filled up with dry rubble masonry, and drawn in at the top to two feet in diameter. Whenever the building is finished, the water should be removed from the well with buckets if the quantity is small, and with a pump if it be large, to allow the bottom to be cleared of mud and stones. A thick flat stone, reaching from the side of the ring to beyond the centre, should be firmly placed on the ground at the bottom of the well for the wooden pump to stand upon, or for the lead pipe to rest on. If a wooden pump is used, a large flat stone, having a hole in it to embrace the pump, should be laid on a level with the ground upon the ring of the well; but if a lead pipe is preferred, the flat stone should be entire and cover the ring, and the clayey earth thrown over it.

5527. The cost of digging a well in clay, eight feet in diameter and sixteen feet deep, and building a ring three feet in diameter with dry rubble masonry, is only L.5, exclusive of carriage and the cost of the pumps.

5528. A larch pump of from 15 to 20 feet in length costs from L.3 to L.3, 10s., and a lead one L.2, 10, with 1s. 2d. per lineal foot for pipe of the depth of the well. The wooden pump will last perhaps twenty years, and the lead one a lifetime, with ordinary care: and the lead at all times is worth something.

5529. It may happen that a well has to be sunk in fine sand or loose gravel, when the ordinary mode of sinking and of building the ring will not answer. For such a case, Mr James Wilson, Bonhill, Dumbartonshire, has obligingly sent me the specifications and mode of digging and building, which he followed in making a well in sand and gravel. The diameter of the well to be three feet six inches inside of the building, and the building, instead of rubble, to be of droved ashler, each stone 8 inches broad in the bed, 12 inches deep, about 21 $\frac{3}{4}$ inches long, in the chord of the arc of a circle on the one side, and 17 inches long in a straight line, on the other side. The outside of the stones to

be formed neatly to a circle, and their inside into an octagon. Beds to be square; ends properly bevelled and wrought correctly to a mould; each course to contain 8 stones of equal size; a ring board to be formed of willow, not to taste the water, $8\frac{1}{2}$ inches broad, $1\frac{1}{2}$ or 2 inches thick, and half an inch larger than the outside circle of the stones. The ring-board could be made stronger in two courses of four pieces of equal size. In building upon the ring-board, the first course of stones to have the centres of their face raised perpendicular to the inside of the ring-board. The centres of each stone of the second course to be placed over the joints of the preceding course, and also perpendicular to the inside of the ring-board. The inside face of each stone being a straight line, the inside diameter of the well being $3\frac{1}{2}$ feet, and the ring-board being correctly made, the inside ends of each stone will be back $1\frac{1}{2}$ inch from the centre of the face of each stone in the course immediately above it, and so on with every course. A small stick made as a gauge at one end, of $1\frac{1}{2}$ inch length, will be found handy for setting the stones. The outside circle must be most carefully made. The upper course to form a square instead of an octagon for the covers to rest on, and to slope to one side, to carry the water off the top of the well. The covers to be drowed, and in three pieces, one of which to cover the building on one side and half of the well, and to be half-checked where the other two stones meet it in the middle, and they are to be half-checked into it, also half-checked into each other where they meet in the middle, and to cover the other side of the building. One of the stones covering a portion of the well to have an iron ring in it, by which to lift it freely out of the checks of the other two stones. The joints of the covers to be filled with putty well mixed with white lead, to prevent water from the surface getting into the well.

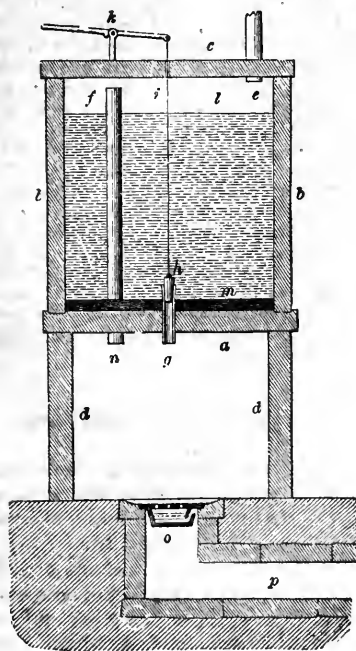
5530. The method of sinking the well is thus described by Mr Wilson:—"I had the stones dressed, drowed to a mould as specified, and all ready before breaking ground, when I made a rod two inches longer than the extreme diameter of the ring-board; described the circle on the surface with it, and gave it to the labourer as a gauge, that he might not take out any more sand and gravel than was necessary to let the ring-board in with ease. I had about five feet of gravel, which I should always like to go through before laying in the ring-board. There were then two feet of fine sand, when water appeared by taking a shovelful out of the centre. I then ordered the ring-board to be put in and levelled, and built upon to the top of seven courses, filling up as it was built the back of each course with fine sand, loosely put in with a shovel, to steady the building when sinking. I then commenced taking gravel out of the centre with a short shovel, and a bucket with a rope attached to it to be drawn up with a winch and handle. In about three hours of an afternoon there was about a foot of water. Next day I commenced taking out a barrowful of sand, and two or three bucketfuls of water alternately, till in other three hours I had got down

altogether about eleven feet six inches, when the water flowed in so much I could not proceed further, and it rose to its level of three feet eight inches. The building went down steadily, and did not seem to be an eighth of an inch off the level at which it was first set. Other four courses were then built, and the covers put on, and the pump-frame erected several feet from the side of the well, where an inclined plane and gutter had been formed to carry off the water. The pump I use is a copper chamber, four inches in diameter, with brass boxes, and a two-inch lead pipe attached to the chamber, and laid into the well through the side of the building about two feet below the surface.²² This may be regarded as an expensive method of forming a well, and it is so; but it is clear that, unless the ring is made of stones well connected together, the building would not sink without dislocation; and it is not possible to dig sand out of a well of considerable depth and build its ring, by means less expensive than this. It will be seen that the truer the circle and better the workmanship of the outside of the ring, the building will subside the better without risk of having the stones displaced by rubbing against the sand and gravel. This method of sinking permits the well being made deeper, if required, at any future period; and this method of building renders the well accessible at all times for repairs, by affording steps in the angles of the octagon, for plumbers and others, as the means of descending and ascending the well with ease.

5531. Rain-water for domestic purposes is collected in cisterns. The form of a *rain-water cistern*, represented by fig. 441, I have found useful for allowing the undisturbed deposition of impurities, and at the same time the quick flowing off of the purer water, without disturbing the deposition. Let $a b c b$ be a cistern of stone or wood, placed at a convenient spot of the steading or farm-house, for the reception of rain-water. I have found that such a cistern, of the capacity of 12 cubic feet, holds a sufficient quantity of rain-water for the domestic purposes of an ordinary family. A cistern of 2 feet square at the base, and 3 feet in height, will just contain that quantity; but, as the size of an ordinary wash-tub is 2 feet in diameter, the space between d and d must be made 2 feet 6 inches at least, and the height of the cistern b would be 2 feet; but if more water is required than 12 cubic feet, then the height should be 3 feet, which gives a capacity to the cistern of 18 cubic feet. Suppose the cistern represented in the figure to contain 18 cubic feet, then the area of a will be $2\frac{1}{2}$ feet square, and b 3 feet in height, supported on two upright stones $d d$ of the breadth of the cistern, and 2 feet high. The cistern may either be made of a block of freestone hewn out to the dimensions, or of flags, of which the sides are let into grooves in the bottom and into each other, and imbedded in white-lead, and fastened together with iron clamps, having a stone movable cover c . Or it may be formed of a box of wood, securely fastened at the corners to be water-tight, with a cover of wood, and resting on the stone supports $d d$. Stone, being more

durable, is of course preferable to wood for a cistern that stands out in the open air.

Fig. 441.



A RAIN-WATER CISTERN.

A hollow copper cylinder *g* is fastened perpendicularly into the bottom *a*, having its lower end projecting 1 inch below, and its upper 3 inches above, the respective surfaces of the bottom. The upper end of the copper cylinder is formed to receive a ground truncated cone of copper *h*, called a plug or stopper, which is moved up and down with a lever *k*, by means of the copper rod *i*. The plug *h* must be made water-tight with grease, the rod of which passes through a hole in the cover, to be connected with the lever *k*, whose support or fulcrum is fixed on the cover. These parts are all made of copper, to withstand rusting from the water, with the exception of the lever, which may be of iron painted. The rain-water is supplied to the cistern by the pipe *e*, which descends from the rain-water conductor, and is let through a hole in the cover. The water is represented standing as high as *l*; but in case it should rise to overflow, it can pass off by the lead waste-pipe *f*, which is secured and movable at pleasure in a ground-washer *n*, whose upper end is made flush with the upper surface of the bottom *a*. After the water has entered the cistern, it gets leave to settle its sediment, which it may do to the height of the upper end of *g*. The sediment is represented by *m*, and when it accumulates to *h*, the cover *c* should be taken off, and the waste-pipe *f* removed, and the cistern cleaned com-

pletely out by the washer *n*. The waste water runs away through the air-trap *o*, and along the drain *p*. It is more convenient to have two small than one large cistern, as, while the water is rising in the one, that in the other gets leave to settle. The cost of such a cistern, with dived stones, and to contain 18 cubic feet, with the proper mountings, may be about L.5. I think it right to say, in commendation of this form of water-cistern, that in no case have I known the water about the plug to be frozen, in consequence, perhaps, of the non-conducting power of the mud in the bottom of the cistern. The rod *i* has sometimes become fast to the ice on the top of the water at *l*, but a little boiling water poured down by the side of the rod through the hole in the cover, by means of a funnel, soon freed it from restraint.

5532. Water for domestic purposes is known as *hard* or *soft*. Most water from springs is hard, and that in rivers soft; because, although most of the water of rivers is derived from springs, it becomes soft by long exposure to the air, when it deposits the materials that make it hard. Water is hard when it holds in solution certain salts, particularly sulphate of lime, (gypsum,) and the carbonate of lime, even in very small quantities. Water can dissolve $\frac{1}{1000}$ part of its weight of gypsum; but, according to Dr Dalton, $\frac{1}{10000}$ part is sufficient to render it hard; and Mr Cavendish says, that 1200 grains of water containing carbonic acid will hold in solution 1 grain of limestone. Limestone is insoluble in pure water; but water containing carbonic acid in solution can dissolve it. Water is said to be hard when it will not dissolve but decompose soap. Soft water, on the other hand, does not decompose, but combines easily with soap and dissolves it. Hard water is not so fit as soft for many culinary purposes, such as making tea and boiling vegetables. It is therefore of importance for you to know when water is in a hard or soft state. By placing a few thin slices of white soap in a clean tumbler of the water to be examined, its *hardness* will be indicated by *white flakes or curdy particles around the soap*, the effect of decomposition, the acids of the salts in the water combining with the alkali of the soap and leaving the fatty matter.

5533. "To discover whether the hardness be owing to the presence of limestone or gypsum, the following chemical tests," says Mr Reid, "may be applied: A solution of the nitrate of barytes will produce a white precipitate with water containing either gypsum or limestone; if limestone have been present in the water, the precipitate will be dissolved, and the liquid rendered clear on adding a few drops of pure nitric acid; if the presence of gypsum caused the precipitate, this will not be dissolved by the nitric acid. A solution of the sugar of lead may be used in the same way, but the nitrate of barytes is preferred." *

5534. As to a practical remedy for hard water, boiling will remove the lime. The carbonic acid

* Reid's *Chemistry of Nature*, p. 199.

in excess in the water is converted into the gaseous form, and the carbonate of lime then becoming insoluble, falls to the bottom of the vessel. Hence the incrustation of tea-kettles. If the hardness is caused by gypsum, a little pearl-ash or soda (carbonate of potash or carbonate of soda) will remove it, and the lime of the water will also be precipitated with the carbonic acid of the pearl ash or soda.

5535. Water as a beverage would be insipid, and even nauseous, without the gaseous and saline matters usually found in it. They give a natural seasoning and a sparkling appearance to it; thereby rendering it not only agreeable to the taste, but more wholesome to the stomach. Every one knows the mawkish taste which boiled water has when drunk alone.

5536. As I am on the subject of water, a few words may here be said on the making of *horse-ponds*. When a small stream passes the steading, it is easy to make a pond serve the purpose of horses drinking and washing in it, and the water in such a pond will always be pure and clean. But it may happen, for the sake of convenience, when there is no stream, that a pond should be dug in clay, in which case the water in it will always be dirty and offensive, unless means are used to bring water by a pipe from a distance. If the subsoil is gravelly, the water will with difficulty be retained on it, on which account the bottom should be puddled with clay. Puddling is a very simple process, and may be performed in this manner. Let a quantity of tenacious clay be beaten smooth with a wooden rammer, mixing with it about one-fourth part of its bulk of slaked lime, which has the effect of deterring worms making holes in it. After the mass has lain for some time souring, let large balls of it be formed and thrown forcibly on the bottom of the pond, made dry for the purpose, and beaten down with a rammer or tramped with men's feet, until a coating 6 or 7 inches in thickness is formed, or more, if there is plenty of clay. Then let a quantity of clean gravel be beaten with the rammer into the upper surface of the clay before it has had time to harden. Should the pond be large, and the weather at the time of making it so dry as to harden the clay before its entire bottom can be covered with it, let the puddling and gravelling proceed together by degrees. Above the coating of gravel, let a substantial causeway of stones and sand be formed to resist the action of the horses' feet, and which, if properly protected at the ends, and finished on the open side of the pond, will withstand that action for a long time. I have seen a pond recommended to be made, into which the horses enter at one end, and pass through it by the other. This is a convenient shape of pond, in as far as it admits of the uninterrupted passage of the horses *through* it. But it is liable to serious objections. Being contracted laterally, the pair of horses which first descend to drink will occupy the greatest proportion of its whole breadth, and while in that position, the succeeding pair must drink the muddy water at their heels; and, as the con-

tracted form precludes easy turning in the deepest part of the water, none of the rest of the horses can be permitted to drink at the opposite or open end of the pond. A much better form of pond, I conceive, is with an open side, having the opposite side fenced, and the water supplied clean at the upper end, and made to flow immediately away by the lower. At such a pond a number of horses can stand in a row to drink at the same time, and easily pass each other in the act of washing the legs after drinking. As to the depth, no horse-pond should ever exceed the height of the horses' knees. The water should on no account reach their bellies; for although I am quite aware of ploughmen being desirous to wade their horses deep, and of even wishing to see their sides laved with water, to save themselves some trouble in cleaning, that is no reason why you should run the risk of endangering the health of your horses by making the pond deeper than the knee. (1417.)

ON COTTAGES FOR FARM-SERVANTS.

5537. It is as necessary to obtain good accommodation on the farm for the farm-servants—the numbers and duties of whom I have already enumerated from (55) to (69)—as for the farmer himself and his stock. Until a few years since, however, the dwellings of farm-labourers did not receive that attention, from either landlord or tenant, to render them comfortable as they ought to have had; not, I believe, from any disregard towards the welfare of that useful and indispensable class of servants, but chiefly because they themselves made no formal complaint of the state of the accommodation afforded them, and seemed contented with such houses as they got, provided they obtained a situation under a good master, and on a good farm. The general character of the hinds' houses some years ago may be learned from these remarks by Dr Gilly, Vicar of Norham, in Northumberland: "The general character of the best of the old-fashioned hinds' cottages in the neighbourhood is bad at the best. They have to bring everything with them—partitions, window-frames, fixtures of all kinds, grates, and a substitute for ceiling; for they are, as I have already called them, mere sheds. They have no byre for their cows, no sties for their pigs, no pumps or wells, nothing to promote cleanliness or comfort. The average size of these sheds is about 24 feet by 16. They are dark and unwholesome. The windows do not open, and many of them are not larger

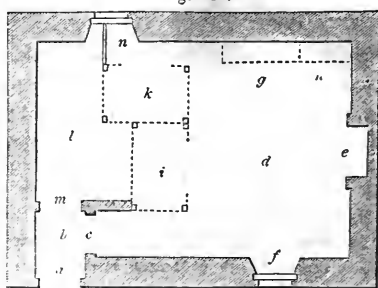
than 20 inches by 16. Into this space within the shed are crowded 8, 10, and even 12 persons. How they lie down to rest, how they sleep, how they can preserve common decency, how unutterable horrors are avoided, is beyond all conception. The case is aggravated when there is a young woman to be lodged in this confined space, who is not a member of the family, but is hired to do the field-work, for which every hind is bound to provide a female. It shocks every feeling of propriety to think that, in a room, and within such a space as I have been describing, civilised beings should be herding together, without a decent separation of age and sex. So long as the agricultural system in this district requires the hind to find room for a fellow-servant of the other sex in his cabin, the least that morality and decency can demand is, that he should have a second apartment, where the unmarried female, and those of a tender age, should sleep apart from him and his wife.* I have seen many houses of this description upon farms, but now they are becoming fewer every year. Whenever a lease is renewed, if the cottages are in a bad state of repair, they are amended both by repairs on the outside, and better accommodation within; and when so bad as not fit to be repaired, they are pulled down, and others of a greatly amended form and appearance are built instead. This is now the rule under adoption by landowners generally, and the contrary conduct is happily the exception.

5538. But in the case of some proprietors, the desire for building very fine large cottages is manifesting itself; and such a spirit ought to be deprecated as well as the very opposite extreme which Dr Gilly condemns. A larger house than a hind can well furnish is a burden to him; and whatever part he cannot furnish, becomes a dirty lumber room, or is let to some stranger in the capacity of a boarder—a very objectionable class of persons on any farm. A house that will just accommodate the number of persons of his household is what the hind wants; and the object can only be attained by building cottages of different sizes. The usual practice, when building cottages for farm-

servants, is to adopt a uniform plan, upon which all are built. The practice is not founded on sound principle, nor even on expediency; because it implies that families consisting of very different numbers should, nevertheless, be accommodated within similar spaces. Instead, therefore, of a family accommodating itself to the size of the cottage, the cottage ought to be adapted to the size of the family; and there is no way of fixing the proportions between the cottages and their inmates but by building them with different extents of accommodation, for families of different numbers. This is the only rational course to pursue; and in pursuance of it, it is as easy to build a given number of cottages on different plans, as on the same plan. Following out this principle, I shall give a number of plans, suited to families of different sizes, taken from practical examples, but modified, in some instances, to suit my own notions of the conveniences, comforts, and means of cleanliness which such dwellings should possess.

5539. Objections have been made to accommodating a family in one room; but the force of the objections entirely depends upon the number of the family. In some parts of the country the hind's family may consist of himself and wife only, in which case a single room and a single bed will suffice for their accommodation. In other parts the hind is obliged to have a female to work in the fields as a field-worker, when a bed must be procured for her. In this case, at least two beds are required in the house; and even these may be accommodated in one room. Fig. 442 shows

Fig. 442.



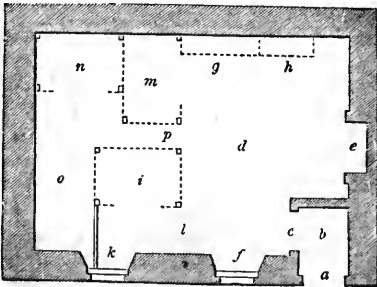
PLAN OF A SMALL HIND'S HOUSE OF ONE ROOM.

* Gilly's *Appeal on Behalf of the Peasantry of the Border*, p. 19 and 20.

the manner of accommodating two beds in one room: *a* is the door of entrance; *b* the porch; *c* the door into the room *d*; *e* is the fire-place; *f* the window of the room; *g* the plate-rack for holding the crockery, &c.; *h* the dresser; *i* and *k* are the two beds, *i* entering from the room *d*, and *k* from the small room *n*, provided with a window, which is divided by a partition between this room and the store-room *l*, which is entered from the porch by the door *m*. The apartment *n* has a door hinged on the corner of the bed *k*, if a box-bed, and on the wall if not so. If the beds are box-beds, which is the most common form, the inmates at night will be sufficiently separated, the married couple entering the bed *i* from the apartment *d*, and the field-worker *k* from the small chamber *n*. Should the beds be of the tent-bed form, with curtains, farther separation might be effected by a wooden partition between the two beds, and at the ends of *k* next *l* and *d*, and at the back of *i* next *l*. Such a cottage measures 22 feet in length, and 15 in breadth—giving the floor of *d* a space of 15 feet by 11½, which is enough for three adult persons.

5540. Even three beds might be accommodated in one room, as shown in fig. 443, where *a* is the entrance door; *b* the

Fig. 443.



PLAN OF A LARGE HIND'S HOUSE OF ONE ROOM.

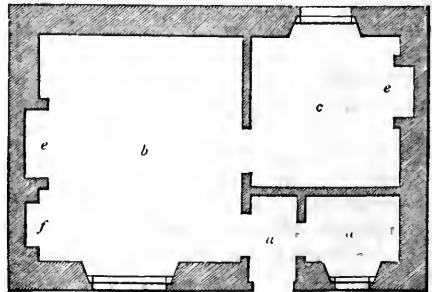
porch; *c* the door of the apartment *d*; *e* the fire-place; *f* the window of the room; *g* the plate-rack; *h* the dresser; *i* *m* *n* are three beds, so arranged that *m* enters from the room *d*, *i* from the small closet entered by the door *l*, and having the window *k* divided between it and the store-room *o*, which is entered by the passage *p*, where is a door, and has a bed in it, *n*. Box-beds would make a complete separation of their occupants by being so arranged. Tent-

beds would require wooden partitions to separate *m* from *n*; and *i* would require one along the back next *p*, and at the end next *o*. If this cottage were of the same size as fig. 442, the room *d* would be equally large; but that the lobby *b* is taken off it, to make up for which the size should be 25 feet in length, and 15 in breadth.

5541. Box-beds are objected to by medical men, as they are too confined and inconvenient in form when any of the family are sick. Modifications in their form may be effected chiefly by having the back and ends to open on hinges, and the top made movable, to promote ventilation, as well as to allow freer access to the patient. Curtains suspended from movable rods, made to draw forward in front, instead of sliding panels, have been recommended, to screen the person dressing and undressing, when the beds do not occupy separate apartments; but were the beds arranged in the manner represented in figs. 442 and 443, such a contrivance with the curtains would not be required. It is questionable, however, that box-beds will be voluntarily relinquished by farm servants, and certainly not so until every cottage is accommodated with fixed beds; and if these have the alcove form, which most fixed beds have, they are equally inconvenient for a sick patient as the box-bed itself.

5542. But it must be owned that, where more than one bed is required in a hind's house, a separate room for it is better than any arrangement that can be made with the beds within one room, and the feeling of security and separation is more satisfactory in the second apartment. Fig. 444

Fig. 444.



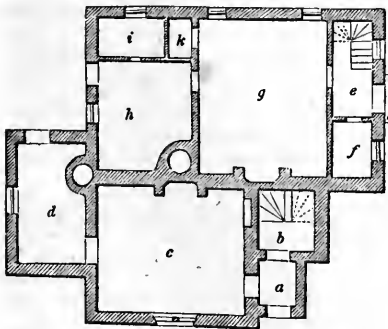
PLAN OF A HIND'S HOUSE WITH TWO ROOMS.

gives the ground-plan of such a cottage, where *a* is the entrance porch 3 feet 3 inches by 4 feet 9 inches; *b* the apartment 15 feet by 14, with a window; *c* the bedroom 10 feet square, with a window; *d* a light pantry, 4 feet 9 inches by 6 feet 6 inches; *ee* are fire-places, 4½ feet by 3½ feet; and *f* a wall-press 3 feet wide. One bed can stand against the back wall of *b* for the hind and his wife, and another if required for two children; and one bed might be put into the room *c*, for the field-worker, and another for two children if required. Thus three adult persons can well be accommodated in such a house, along with four children if required.

5543. In such a house as fig. 444 tents and curtains would look neat and be appropriate. Iron bedsteads are now quite common, and, for convenience of putting up, and taking down, and avoiding fracture, they are much better adapted for hinds than wooden ones. They also possess the advantage of giving no shelter to bugs. The curtains of beds to be used in such houses ought to be made of wool to resist fire, and not of cotton, which would, in the circumstances, only be a little less dangerous than a covering of tinder.

5544. Instead of having the sleeping apartments upon the ground-floor, they may be placed in a story above. Fig. 445 shows such an arrangement, in which

Fig. 445.



PLAN OF HINDS' HOUSES HAVING BED-ROOMS IN A SECOND STOREY.

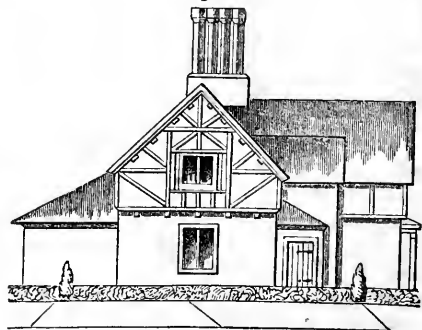
a is the entrance porch of a small house; *b* the staircase leading to the upper story; *c* the room, entering from the porch *a*, having a window, a fireplace and wall-press, and entering to a back-kitchen *d*,

having a window, a boiler, and a back door. This apartment is useful for washing clothes in, and doing such things as to leave the sitting-room *c* always clean and comfortable. One large or two small bedrooms are placed over the sitting-room *c*.

5545. A larger house has an entrance porch *e*, which is also the staircase for the upper story; *g* is the sitting-room entering from the porch, and having two windows, a fireplace, a pantry *k*, and entering to the back-kitchen *h*, which has a window, boiler, and back-door, and enters to a light closet *i*. The light closet *f* enters from the porch *e*. Two large or three small bedrooms are placed over the apartments *g* and *h*, and the closets *i* and *k*.

5546. Hinds' houses are most commonly built in long rows, and when several are required for a large farm, they frequently assume the form of three sides of a square. When outhouses are afforded, which ought always to be, much inconvenience is experienced by the inhabitants living in long rows of houses, in going to and from them. This row-form originated, no doubt, because of a larger number of houses being erected at the same expense, than in any other form, and economy of the ground taken up by them had also entered into the calculation. For comfort and convenience combined, no form is equal to the double house, having entrances at different parts, and the fire-places in the centre of the building. Fig. 446 represents the elevation of the houses

Fig. 446.



ELEVATION OF DOUBLE HINDS' HOUSES.

whose ground-plans are given in fig. 445, and although here represented in a more

ornamental style than hinds' houses need be, the construction combines ornament with use; and now that the duty is taken off building bricks, the upper story, the rooms of which partly occupy the roof, might be made to have a light and elegant appearance, and yet not be expensive, if built with brick. Pairs of cottages, of whatever construction, should not be built so close together as to give force to a current of air between them.

5547. A second sitting-room in a hind's house is an unnecessary appendage to it; it will never be used as such. When in the second story it will be converted into a sleeping-room; and when on the ground-floor, into a meal or potato store, beside the beds that may be put into it. The fire will never be kindled in it, and it will become damp and cold. It is only when the labourer is a fixed resident, holding directly under the landlord, that he will furnish his second room in the ground-floor comfortably, and warm it by occasional fires.

5548. Single cottages with a ground-plan such as figs. 442 and 443 would cost about £53, thus:—

82 cubic yards of building	£14	7	0
151 square feet of hewn stone	7	11	0
Roofing and slating	16	16	0
Joiner-work and furnishings	14	6	0
	£53	0	0

If such cottages are made double, they might be erected for £100. Such a cottage as fig. 444 would cost about £63, and in the double form perhaps £120. Figs. 445 and 446 are in too ornamental a style for farms; but in a plain style and with the accommodation afforded by them, they could not be built under a considerable sum more than I have mentioned.*

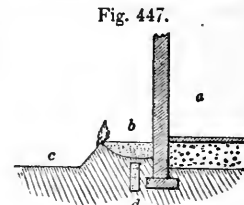
5549. I do not approve of ash-pits, privies, and pig-sties being placed near dwelling-houses. It is highly proper that these accommodations should be provided for the people, but certainly not close to their dwellings. The trouble of walking a few yards to those places is well compensated in avoiding the nuisance that would be experienced in the vicinage.

* *Transactions of the Highland and Agricultural Society*, March 1850, p. 275, and Jan. 1848, p. 202.

† *Journal of Agriculture*, July 1847, p. 1.

The offices to each cottage may cost about £15.

5550. Too frequently little attention is paid to the state of the site in which hinds' houses are built. They are very commonly built along the side of the public road, open to the gaze of every passenger, and in the way of accidents to the children; and their floors under the level of the curve of the road. They ought to be away from a public road, and their floors ought to be elevated at least one foot above the surface of the ground. Fig. 447 gives a section of the manner



SECTION OF THE FOUNDATION OF A HIND'S HOUSE.

in which the foundation of hinds' houses ought to be constructed, where *a* is the pavement of the floor of the room resting upon broken stones to keep it dry; *b* the broad gravelled footpath along the front of the wall; *c* the surface of the ground on the road, some inches below the level of the footpath; and *d* the drain to carry away the water that may chance to fall upon the footpath. A border of earth may be made along the front of the house, and a fence of low hedging placed between it and the footpath, which in that case would be made where the road *c* is.

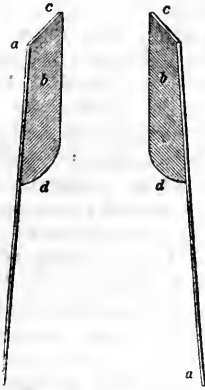
5551. Much comfort may be promoted within a cottage by a few simple means kept in view at its erection. One of the means is to have the fireplace in the centre of the house, and not in the gable, because the mason-work absorbs much of the heat from the fire in the latter position, and dissipates it into the open air. A double cottage secures the advantage of a central heat completely; but if the fire be at the end of a long room, even though it should be in the centre of the house, the remainder of the room will derive little benefit from it: the fire should therefore be in a side wall. No door opening into a room should be near to or on the same side of the apartment as the fireplace. On these conditions being laid down to architects by landowners, cottages would cease to be the uncomfortable dwellings which many are to their occupants.†

5552. No part of a cottage requires so much attention at its erection as the chimney—for a smoky house to a cottager, who has only one chamber with a fireplace, is positive torture. The subject of chimney-building, I am aware, is a difficult one, but from what I can observe, I think chimneys are made too short and too wide. A wide chimney affords room for both a descending and ascending current of air, and a short chimney weakens the draught materially. A long chimney with a contracted top should therefore be expected to carry off the smoke freely. Tredgold says of the contracting of a chimney

near the bottom, "it is like contracting the aperture of a pipe which supplies a jet." The contraction depends on the size of the grate for the fire; and this being kept in view, Tredgold's rule for the contraction at the top is the following:— Let 17 times the length of the grate in inches be divided by the square root of the height of the chimney in feet, and the quotient is the area for the aperture at the top of the chimney in inches. For example, suppose that a grate is 15 inches wide, and the chimney 36 feet high— $17 \times 15 = 255$; and the square root of 36 is 6; therefore 255 divided by 6 = $42\frac{1}{2}$ inches is the area of the top, and the diameter of a circle of $42\frac{1}{2}$ inches in circumference is $5\frac{1}{2}$ inches for the contraction.

5553. The contraction at the top may be made in this manner: Let fig. 448 represent the section of a chimney-

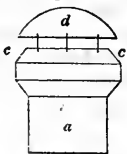
Fig. 448.



METHOD OF CONTRACTING THE TOP OF A CHIMNEY.

5554. In certain situations, and in certain quarters of the wind, a down-draught of smoke is created in the chimney. Those situations may be in the neighbourhood of tall trees, at the base of a hill, or in the lee of a large building, against which, if from one direction, and over which, if from another, the wind may be reflected against or bend in a downward direction upon the top of the chimney. The only safeguard against such a contingency is the placing a top upon the chimney-head, or upon the can represented in fig. 449; but in the latter case the iron cone *b* should not be angled upwards as at *c*, but made

Fig. 449.



TOP OF A CHIMNEY FOR PREVENTING THE DOWN-DRAUGHT OF SMOKE.

level, and it should be placed as much lower down the can as to allow it to take in the top. Fig. 449 represents such a top recommended by Tredgold, where *a* is the part for fixing it to the can or chimney-head; *d* the cover, made circular or con-

ical, for preventing the down-draught of the air from above; and *c c* are the angular edges for directing the wind upwards according to their angle. The top may be made of thin metal of any kind, and painted black. Kites' (of London) diamond deflecting chimney-top has been highly recommended by those who know it.*

5555. The ventilation of cottages I do not interfere with, as the door is generally left much open in them during the day, and were they furnished with the windows given in figs. 78, 79, and 80, which they ought to be, (1134,) the foul air at any time could be easily got rid of. Back doors are generally objectionable in cottages as causing disagreeable draughts even when they are shut, and violent slamming of the other doors when they happen to be opened in windy weather.

5556. The following are the prices of building materials for cottages in England—

Mason and plaster work:—

18-inch stone wall, properly pointed,	£7 per rood superficial.
Bevel stone paving,	7d per foot.
Bath stone for dressings, delivered from the quarry to the builder's yard,	} 1s. 4d. per cubic foot.
Best duchess slating, with malleable metal nails,	
Lathing with best deal laths, "render, float and set,"	} 1s. 4d. per square yard.
Render, float and set, or render, float, and twice whiten,	

5557. *Carpenter and Joiner work:—*

Couples,	9 inches by $3\frac{1}{2}$ inches.	} of sound dry elm at 2s. per cubic foot, including the sawing.
Purlions,	6 .. 4 ..	
Wall-plates,	7 .. $2\frac{1}{2}$..	
Flooring joists,	8 .. 2 ..	
Lintels,	10 .. 4 ..	
Bond timber,	3 .. 2 ..	} of yellow deal at 2s. 8d. per cubic foot, including the sawing.
Door frames,	3 .. 4 ..	
Rafters,	3 .. $2\frac{1}{2}$..	} of white deal at 2s. 4d. per cubic foot, including the sawing.
Ceiling joists,	4 .. $1\frac{1}{2}$..	

The landings and bedroom floors to be laid with inch white-deal flooring boards.
The partitions on the landings to be $\frac{3}{4}$ inch white deal, braced.

5558. *Plumber and Painter work:—*

The valleys in the roof to be laid with 6 lb lead. All external woodwork, and all internal usually painted, to be well primed and have three coats drab. The windows to be glazed with leaded lights, in diamonds, and each room to have a casement to open.†

5559. No cottage can be kept dry at the foundation, even with drains, if the rain-water is not carried off by spouts. It would be expensive to make, and troublesome to keep in repair, a rain-water cistern at every cottage, and it would require a large one to supply the wants of a family; and were more than one claimant allowed to each cistern, it would be a source of endless quarrels. A good pump is all that is necessary to supply water to hinds' houses, and it is a necessary of which they are too often deprived.

* *Journal of Agriculture*, July 1849, p. 45-50.

† *Weaver's Designs of Cottages*.

ON INSURANCE AGAINST FIRE AND DISEASE.

5560. *Fire*.—It is very short-sighted policy in a farmer to neglect to insure his stock and crop every year against destruction by fire. The premium is only 3s. in Scotland, and 4s. in England, per £100 value—farm-stocking being exempt from the duty of 3s. per cent. The premium used to be only 2s. per cent; but since the prevalence of smoking tobacco, and the use of lucifer matches by the country people, it has been raised. It is not necessary to insure the entire crop or stock, inasmuch as it is not at all probable that the whole would be destroyed by any one fire. The houses should also be insured, and the landlord ought to pay the insurance, since they are his property; and they are as safe in the possession of a tenant as in his own, since the tenant runs the risk of losing his crop and stock before the buildings can catch fire. The premium of insurance for farm-buildings is 2s. 6d., and for farm-houses and hinds' houses, 2s. per £100 value; and there are, besides, 3s. per cent of duty.

5561. *Fire-engines*.—I am surprised how fire is extinguished at farm-steadings, which contain so much inflammable materials, since no fire-engine of any description is kept on a farm. The ordinary fire-engines are generally at a great distance from farms—not nearer than the nearest town, and probably not nearer than a large town. This being the case, it is peculiarly interesting to farmers to learn that a quick and efficient means of extinguishing fire has lately been announced. It has been well said, that “we are so much accustomed to regard water as the only available material which can be employed in case of conflagration, that the scientific man has hitherto been diverted from devising means of applying other well-known agents possessing the same power; and yet water is but a feeble ally, even when it can be had, while the having it at command involves such heavy and costly apparatus, that it can scarcely be called available, unless in cities. As for country houses, villages, or rural property, that may be said to be, by our present arrangements, consigned to almost inevitable destruction in case of fire.” A small jet of water thrown on a large mass of heated

materials should tend rather to increase than diminish combustion, since a great mass of heat can decompose a thin jet of water, one element of which is actually the principle of inflammability, and the other the supporter of combustion. “The immense ratio,” says Mr Phillips, the inventor of a new method of extinguishing fire, “in which fire is multiplied by time, makes it an important desideratum to have at hand the means of extinguishing a fire as soon as possible after discovery. The rapidity of its progress over inflammable materials is such, that a fire extinguishable by one gallon of water will in five minutes require one hundred gallons, and in ten minutes, one thousand gallons;” a supply, it is needless to say, there is generally no means of procuring with the necessary promptness. Where Mr Phillips' Fire-annihilator is at hand, a fire may be extinguished while a man was mounting a horse, in order to search for a fire-engine. As it is not in my power to describe this machine, or give a figure of it, not having seen it, I shall relate an experiment that was made with one before a party at the Gas-works, Vauxhall, London. “Mr Phillips explained that the agent by which he sought to accomplish his object was a mixture of gas and vapour. After several experiments on a small scale, to show the success he had attained by these means, the attention of the company was directed to a compartment of a large open building, quite 20 feet high inside, which was fitted up with partitions and temporary joisting of light wood, well soaked with pitch and turpentine, and overhung besides with rags and shavings soaked in like manner. The torch was applied to this erection, and the flames, which ascended immediately, at length roared with a vehemence which drove the spectators back to a distance of 40 feet, and was already beyond the power of water. The inventor then brought forward one of his hand-machines, and threw out a volume of gaseous vapour, which, in half a minute, entirely suppressed all flame and combustion; and to show that the vapour which now filled the space was quite innocuous, Mr Phillips mounted into the loft, and passed and repassed through the midst of it with a lighted candle in his hand. The machine with which this effect was accomplished was rather larger than a good-

sized coffee-pot, and consisted of three tin cases, one within another, and mutually communicating. There was a small quantity of water in the bottom of the machine, and in the centre case was a composite cake, of the size and colour of peat—containing, in the middle of it, a phial of sulphuric acid and chloride of potassium. In order to put the machine into action, this phial is broken, and a gaseous vapour is generated so rapidly and in such quantity that it immediately rushes out from a lateral spout with great impetuosity. Mr Phillips explained that a machine of any size could be made according to the purpose for which it was intended, and that a company was at length formed to carry the invention into effect, their office being at No. 105 Leadenhall Street.”

5562. There are five sizes of this machine made, varying in price from £3 to £7 each. Each charge for each size of machine respectively costs from 4s. to 17s. They seem suited to all farm buildings.

5563. *Cattle insurance.*—Since the ravages by pleuro-pneumonia amongst the cattle, and the small-pox amongst the sheep became so prevalent, a Cattle Insurance Company was established in 1844 in London, for the protection of individual farmers against the loss of stock by disease. An attempt failed some years ago to establish a company in Scotland having a similar object. By the regulations of the Company, it appears that the stock desired to be insured are inspected by a person appointed by the Company, and on their value being thus fixed, the premium is paid. The premium is 4 $\frac{3}{4}$ d. in the pound, in ordinary cases, of cattle, and in that of pleuro-pneumonia, it is 6d. in the pound. High-bred stock pays according to agreement, and animals are not insured under six months old. Sheep pay 1s. in the pound, and upwards. Horses employed for agricultural purposes pay 7 $\frac{1}{4}$ d. in the pound, and upwards. Hackneys and carriage-horses, 8 $\frac{1}{2}$ d. in the pound; draught-horses, 9 $\frac{1}{2}$ d. in the pound, and upwards. Entire horses, 1s. in the pound, and upwards. Glandered horses by agreement. The owner of the stock, in case of loss, receives three-fourths of the amount on which the premium has been paid, and one-fourth of the produce

of the skin and carcass. He may add to, substitute, or exchange his stock under certain regulations. The office is in the Strand, London, and agents are to be found in the country.

5564. *Hail-insurance.*—The farmers' crops, since 1840, have also been insured against the loss incurred by hail-storms, by one of the Fire Companies of London in the Strand. Sometimes hail does material damage in England, especially to the proprietors of hot-houses; but in Scotland, such a source of loss is of rare occurrence. In August 1850, however, a hail-storm occurred in a part of Forfarshire, in the neighbourhood of the town of Brechin, which did much damage to the crop on the eve of being cut down.

5565. *Cow-clubs.*—These clubs are a sort of insurance against loss; but I presume that insurance with cattle insurance companies are intended to supersede them. Cow-clubs were established and are supported by labourers and hinds who possess cows, and to whom the loss of their cows by calving or disease is a very serious affair. I once knew a hind thrown into a great state of wretchedness by the loss of his cow, upon which his large family depended mainly for support. The following are the rules of the “Brocklesby and Little Lumber Cow Club”: The object of the club is to secure each member, by a system of mutual assurance, from sustaining individually the whole loss arising from the death of a cow—the loss being thus divided amongst all the members. Rules: A treasurer to be appointed, who shall conduct the business of the club, and with whom shall rest the decision as to the admission of members. Each member to pay to the treasurer, on the first Saturday in every calendar month, his subscription (in advance) of 1s. for each cow he may have entered. Any member whose cow shall die, to be entitled to receive from the club the sum of £10. No allowance to be made to any member in respect to any cow above 12 years of age. When a cow dies, the skin to belong to the owner of the cow; but if the carcass can be sold, the money to be paid to the funds of the club. If a cow dies in calving, the calf to belong to the owner of the cow. Any member neglecting to pay his subscription for three

successive months to be deprived of all benefit from the club, and to forfeit what he may have previously paid. Any member leaving the district, or ceasing to keep a cow, to be entitled to receive from the treasurer his proportion of the funds then in hand, after deducting therefrom £20, which was given by Lord Yarborough to the funds on the establishment of the club. A new member to pay on his admission, for each cow he may enter, such a sum as may be the proportion of the general funds to which each cow in the club would be entitled, after deducting therefrom Lord Yarborough's subscription of £20. If the funds in the hands of the treasurer shall at any time not be sufficient to pay the allowance for any cows that may die, the members immediately to make up the deficiency. The monthly subscriptions to be discontinued at the discretion of the treasurer, whenever he shall consider the funds in hand sufficient as a guarantee, until reduced by deaths or otherwise. On the first day of January in every year, the treasurer to make out an account, showing his receipts and payments during the preceding year, and the balance remaining in his hands, and cause the same to be printed, and a copy supplied to each member. It will be observed, from the terms of this club, that these clubs are necessarily confined in the field of their operations.

ON THE PRINCIPLES OF ENCLOSURE, AND ON SHELTER.

5566. The buildings of the farm being thus provided for, we must look at its surface, and finding it unprotected from trespass from the want of fences, we must now turn our attention to have it enclosed in the best manner, so as to place the fields in the most convenient relative position to one another for work in regard to the steading, as the central depot for labour, and to give them that form which is found most economical for conducting the labour therein. But before proceeding actually to lay off and form the different kinds of fences, it will be useful to consider the principles upon which fields should be laid out in aspect and form, and to inquire into the manner fences operate as shelter to crops and live stock.

5567. On contemplating the enclosing of a farm, the question naturally arises to inquire the purpose for which it ought to be enclosed; and the only consideration that would satisfy the inquirer is, whether or not the farm has any stock to confine within given bounds? If there were no stock, it would be difficult to satisfy the mind that any enclosure is required, as is the case with the carse farms, on which they are not wanted; and even if there were stock, no enclosure within the boundary of the farm seems requisite, if the farm consists entirely of pasture-land. Thus, then, the necessity for enclosure is questionable where there is no pasture; and where a ring-fence exists around the farm, it is all that is requisite to keep the stock within its bounds. It does seem reasonable that a ring-fence is requisite, both to prevent your own stock wandering upon your neighbour's farm, and his trespassing upon yours. Whenever we associate, however, the co-existence of arable culture and pasture, a subdivision between the one and the other seems at once necessary, even if the arable land were kept at one side of the farm, and the pasture on the other; but should the two intermingle throughout the farm, there seems as much necessity to subdivide the smaller spaces occupied by each, however numerous, from each other, as were the two formerly supposed large divisions separated, each of which occupied half the extent of the farm. An enclosure of arable land from pasture seems as necessary to confine the stock upon the pasture, as to prevent their trespassing upon the arable.

5568. The necessity for a ring-enclosure being thus satisfactorily impressed upon the mind, the extent of subdivided enclosure must depend not only upon the particular system of arable culture to be pursued upon the farm, but whether the rearing of stock is to be associated with it. Hence enclosures are of two kinds: one a *ring*-enclosure, which constitutes the boundary march of a farm, and separates it from every adjoining farm; the other *individual* enclosure, which surrounds every field separately; and every other sort of enclosure is a modification of these two.

5569. Carse farms, and farms in the

immediate neighbourhood of towns, which are not devoted to the rearing of live stock in summer, as well as pastoral farms, which afford a large range of pasturage to stock, do not necessarily require to be enclosed in subdivisions. It appears to be sufficient protection for them to be provided only with a ring-fence, and with fences along the sides of the public roads that may happen to pass through them. In practice, carse farms are seldom enclosed, on the idea that the ground is too valuable to be occupied by any sort of fence; but this is short-sighted policy, in as far as public roads are near them, and the walking of travellers across them. To the neglect of enclosure may be ascribed the existence of the numerous foot-paths which cross the fields of England. At most, the subdivision of clay-land farms, and those near towns, need not be carried farther than dividing them into as many portions as there are members of the rotation of cropping pursued on each: so that only dairy and mixed-husbandry farms require to be subdivided into individual fields.

5570. The position of a ring-fence is easily determined, which is that of the boundary line of the march, whether between two farms of the same estate, or between the lands of two conterminous properties. On adjoining properties, the ring-fence is usually a mutual one, maintained alike by both proprietors.

5571. The individual fences, on the other hand, are laid off according to several considerations, as, should the farm contain a variety of soils, clayey and sandy, a leading fence should divide them, so as each sort of soil may be enclosed according to the system of husbandry best suited to it. The clayey land will bear the best corn-crops, whilst the sandy will yield the best green crops and pastures, and rear the best live stock. Should the season prove unfavourable to the one class of soil, it may be favourable for the other; and when the markets for corn are depressed, those for live stock may be brisk. A happy juxtaposition of a variety of soils on the same farm serves to maintain its value permanently, amidst circumstances that might much depreciate a farm entirely composed of only one kind of soil.

5572. The line of a fence is determined by the direction to be given to the ridges. The ridges should always, if possible, run N. and S., to allow both their sides to derive equal benefit from the solar rays. On flat ground, this direction may easily be assumed; but the inclination of the rising ground may be E. and W.; and as water detained on the surface of the ground; for however short a time, may do more mischief than the solar rays do good to both sides of ridges at the same time, the direction of the ridges should follow the inclination of the ground, to allow the most rapid egress to surface-water. Where the ground has an inclination both N. and S., the meridian line should be preferred. Where the inclination is complicated, as many ridges should take the N. and S. direction as practicable with the other above mentioned modifications.

5573. The fences should run parallel to the ridges; for whenever this parallelism is neglected, wedge-shaped ridges, or *butts*, as they are technically termed, are formed at one or both sides of the fields. On account of the inequality in the lengths of butts, much more time is consumed in working them than a square piece of ground of the same area. Butts are therefore highly objectionable in fields: but as it is scarcely possible to have full-length parallel ridges on every field of a farm, they are unavoidable. Butts should, however, be put on the boundaries of the farm.

5574. To preserve neatness and uniformity in the ploughing of the fields, the fences should run parallel to one another *in straight lines*. A straight fence along the crown of a round-backed ridge of ground, affords excellent shelter to both sides of it, whether it run N. and S. in the direction of the ridges, or E. and W. across their ends. A fence occupying elevated ground bestows more shelter to fields than in any other position; and such a site should always be chosen for the fence, and particularly for a thorn-hedge, as it will escape the crushing power of a heavy fall of snow in a hollow. But it often happens that the lower ends of fields cannot be enclosed in straight lines, a rivulet or hollow between two rising grounds giving their terminations a serpentine form; in which case the fence

must follow the waving course of the rivulet or hollow ground, in order to preserve a channel at the lowest part of the ground, for the surface-water coming at times from both slopes. A serpentine fence in a hollow affords more shelter than a straight one against the wind, which always comes with force in the line of a valley. A rivulet, or large ditch, necessary for the conveyance of water, should run parallel to the fence, and not across an angle or middle of the field, where it becomes a great hindrance to work, cutting short the ridges on both sides of it into butts.

5575. The *shape* of fields is greatly determined by unavoidable obstacles, natural and artificial. A winding river or valley will give an irregular line to the fence at that end, and the march-fence may run in a direction to cause butts; and another end or side may abut against an old ruin, plantation, or precipice. Where no such obstacles occur, the corners of all the fields should join at right angles with one another; because the plough can approach nearer to the square corners of a field, than to two obtuse and two acute angled corners. It is demonstrable that the shape conducive to the greatest economy in labour is the square, because frequent turnings on short ridges waste much time; and inordinate length of ridges fatigues the horses beyond their strength. The average strength of the horse is, therefore, the measure of the greatest length of ridge that secures the greatest economy in ploughing the field in every direction. It is, I believe, near the mark to say, that horses can draw a plough through cultivated lea-ground, which is the firmest state of the soil, for 250 yards, without requiring to take breath. But as ground already ploughed is of more easy draught than lea, 300 yards in the one case may be as easy work as 250 yards in the other. The average is 275; and as there is more loose ground than lea to plough, 285 yards may be taken as the proper length of ridge on *light* soils. But clay-soils are of heavier draught, so that 275 yards may be taken as the average length of ridge for *all* soils. The square shape might be profitably adopted on clay farm, whose extent being generally small, the break of land for each kind of crop

cannot be large. Taking 250 yards as a long enough furrow for horses on strong clay, the breaks would be squares of 13 acres each; and as many of such breaks could be placed together, to form a principal division of the farm, as there are members in the rotation of cropping, (5080.) But a field of 285 yards square, on loamy ground, being only about $16\frac{3}{4}$ acres, is too small where live stock are reared. A field to contain 25 acres, giving it the shape of a right-angled parallelogram, the direction of the ridges being N. and S., and the length fixed at 285 yards, its breadth should extend to $424\frac{1}{2}$ yards:

5576. A rivulet or hollow between the sides of two fields, causing irregular butts, when the fence between them takes the line of the hollow, the parallelism of the ridges and fences of both fields might be preserved, by running a fence on each side of the hollow ground, and shutting it out from the fields, and planting it.

5577. To show the great waste of time in ploughing short ridges, I will state the results of some experiments made for me to ascertain it by Mr Hay of Whiterigg in Roxburghshire, on land in different states of cropping. The results were the following, on ridges of 15 feet in width.

Ploughing stubble for bare fallow, October 1849.

Length of ridge in yards.	Time taken to plough a ridge.		Time taken to plough an acre.		Loss of time per acre compared with the standard.	
	Hours.	Min.	Hours.	Min.	Hours.	Min.
319	2	40	8	0	Standard.	
290	2	30	8	20 $\frac{1}{2}$	0	20 $\frac{1}{2}$
280	2	25	8	21	0	21
159	1	15	8	45	0	45
102	1	0	9	30	1	30
45	0	30	10	45	2	45
37	0	25	10	54	?	54
78	1	0	12	4	4	4
66	0	5 $\frac{1}{2}$	12	13	4	13

Second ploughing for bare fallow, January 1850.

280	2	20	8	4	Standard.	
172	1	30	8	26 $\frac{1}{2}$	0	22 $\frac{1}{2}$
100	0	55	8	52 $\frac{1}{2}$	0	48 $\frac{1}{2}$
112	1	5	9	22	1	18
86	0	50	9	23	1	19
137	1	20	9	25	1	21
182	1	48	9	34 $\frac{1}{2}$	1	30 $\frac{1}{2}$
37	0	25	10	54	2	50

First ploughing after turnips, April 1850.

262	2	30	8	17	Standard.	
280	2	25	8	21	0	4
203	2	0	9	32	1	15
101	1	5	10	3	1	46
141	1	30	10	18	2	1

5578. From these statements it would appear, that the shorter ridges generally take longer time to be ploughed than the

longer ones, though some anomalies are observable in all the results. For instance, in the first statement, 78 and 66 yards took longer time to have the acre ploughed than 45 and 37 yards, by 1 hour 19 minutes each, which ought not to have been the case. In the second statement, 182 yards took longer time to have the acre ploughed than 86 yards by $11\frac{1}{2}$ minutes. And in the last statement, 141 yards took longer time to the acre ploughed than 101 yards, by 15 minutes. These anomalies might perhaps be explained by supposing, that the shorter ridges were in a more favourable position for being ploughed, as regards inclination or state than the longer, or that the ploughman had taken less time to turn the horses at the landings, than those at the longer ridges. Be that as it may, it is in the experience of every farmer, that short ridges take longer comparative time to be ploughed than long ones; and therefore, when fields are to be set off for enclosure, the ridges ought not to be shorter, if practicable, than from 280 to 300 yards, according as the soil is stronger or lighter. As instances of anomalies in long ridges, I may mention, in experiments made for me by Mr M'Lagan, younger, of Pumpherston, Mid-Lothian, that an acre took only 7 hours 40 minutes to be ploughed, with ridges as long as 570 yards, while one with 420 yards took 8 hours 24 minutes, and another with 250 yards, 9 hours 36 minutes. I have known a large field of 60 acres, two ridges of 10 yards in the breadth of which occupied an acre, and was therefore 484 yards long; but it was inconvenient in many respects to be worked, both in time and length, as well as for the horses and work-people.

5579. Should a public road, or canal, or railway, pass through a farm, the fence should be placed on each side of them; and should an old plantation, quarry, or building, stand in the middle of the land, before it is enclosed, the butts occasioned by them should be placed next the obstacle.

5580. A public road along enclosures is a great convenience to a farm, and it may save the making of one or more farm-roads. Easy access to and from the fields to roads is a great means of maintaining the health and strength of horses, and of

saving the wear and tear of carts and harness in winter.

5581. The *size* of the fields depends in a great measure on the nature of the farm; and yet economy in labour limits both the smallness and largeness of fields. Even on the smallest class of farms employing horse-labour, 10 acres seem a small enough space to labour land to advantage. There are many large farms on which smaller fields than 10 acres may be observed, but a smaller space, fenced around, has a confined look, and the grain crops are evidently affected in them. On the other hand, very large fields, from 50 to 100 acres each, take too long time to have the work finished off, even with a large number of draughts. I should say that a field from 25 to 35 acres is large enough, according to the extent of the farm; though the number of draughts being great on a large farm, the size of the fields should bear some proportion to them. The exact proportion I am not prepared to define, although I think that less than 10 acres make, too small a field for horse-labour to be employed in, and more than 40 acres too large a one for quick despatch of work. The size of farm most in demand, for mixed husbandry, is 500 acres, which give 4 fields of 25 acres, equal to 100 acres, for each member of a rotation of 5 crops. Placing the same kind of crop, and especially green crop and grass, in moderately-sized fields—say of 25 acres each—on different parts of the farm, and most probably in different kinds of soil, a good crop in one of the fields will almost be insured every season; and the whole labour of the farm being, for the time, confined to one moderately-sized field, a good season for ploughing the land, and a safe seed-time and harvest for its crop, seem to be placed within the power of the farmer against any great or sudden change of weather. The same mode of reasoning on the size of fields may be applied to any other sort of farming.

5582. The *position* of fields is a matter of some importance. I have said that the ridges should run N. and S., (5572,) and that about 300 yards are of sufficient length for the ridges, (5575;) and as the fields in general are of the best size for economy of labour at 25 acres, (5581,) and with a form as nearly approaching to the

square as is compatible with these premises (5575,) it follows that the fields should be placed with their shorter ridges or breadth N. and S., and with their length E. and W. Were they placed thoughtlessly the opposite way, the ridges to run N. and S. would either be 425 yards long, which would be too long for the horses; and if made to lie E. and W. one side only would have the benefit of the sun.

5583. Mountain-pastures, exclusively devoted to the use of live stock, should be enclosed in large divisions, because cattle and sheep are generally reared in large numbers on pastoral farms. Mountain live stock possess more active habits, and have a stronger instinct to search for food than those of the plain; and as the herbage of the mountains is rather scanty than otherwise, stock there require ample space to roam over in order to satisfy their wants.

5584. Although very small enclosures under constant cultivation are unwholesome to grain crops, two or three small enclosures of from 1 to 5 acres in grass, near the steading, are almost indispensable on every farm on which live stock is reared. These may be used by tups when out of season,—by calves when weaning from the milk,—by ewes when lambing,—by mares and foals for a few weeks until the mares regain their strength,—by a stallion at grass,—or as hospitals for sick and convalescent animals. Such small fields are much more useful and valuable in grass than under the plough.

5585. The number of fields depends partly on the size of the farm, and partly on the rotation of crops carried on in it (5080.) The interior of pure clay-land farms devoted to the raising of corn alone, especially of wheat, should be no more subdivided than to have a fenced division for each course in the rotation of crops made up of convenient square-shaped fields of the extent determined on in (5575.) To subdivide a clay-land farm, on which no stock is reared in summer, into small fields, would be to devote an unnecessary waste of ground to fences. To save expense in working, and waste of ground in fences, on smaller farms of loamy soils than 125 acres—which are made up of 5 times the number of members in a rotation of 25

acres, (the size of the fields,) and which cannot rear much stock—single fields should correspond in number with the members in the rotation; and should a smaller quantity of grass or green crop be at any time wanted for a particular purpose than a whole field, a temporary fence might be used in preference to enclosing the farm into very small fields. With regard to farms of considerable extent on soil of various textures, quite a different element from the preceding case enters into the consideration that determines the number of the fields. On enclosing a farm, where much stock is raised, the mere economy of labouring each field is not so much an object of solicitude as the welfare of the stock; and as stock always thrive best on fresh pasture, and when only a few of the same kind are herded together, it follows that each inclosure should not be of large extent—perhaps not exceeding 25 acres—so that 285 yards by 425 yards would embrace an enclosure of convenient size for the grazing of cattle during the summer, and the feeding of sheep on turnips in the winter. Suppose, then, that the enclosures contain 25 acres each, and that the 5-course rotation is followed, a farm with 2 enclosures to each member of the rotation would contain 250 acres, which is as small extent of ground as the mixed husbandry can be advantageously practised upon; and with 4 enclosures to each member of the course, the farm would contain 500 acres, and 6 enclosures would give 750 acres—which is as large an arable farm as most farmers have capital to stock.

5586. In enclosing any farm intended for the use of live stock, access to good water should never be overlooked, though it too often is. Should a rivulet not be within reach, spring-water should be obtained either by sinking wells, laying pipes, or making conduits. The best pasture will never improve the condition of live stock without good water; and without an abundant supply, graziers will not hire even the best grass for cattle and horses, though they may for sheep.

5587. The evils of enclosing fields very closely have been urged against enclosures altogether; and it is alleged that the crops are liable to be more injured by being lodged in confined fields than in open ones.

The allegation is quite true; but it applies rather to an abuse in practice than against the principles of enclosing. Close fields, of whatever size, should always be kept in grass for stock; and in order to avoid their flies, a shed for harbouring in will greatly prevent their attacks. Even as regards corn, a sheltered field ripens the crops earlier than an open one, which may arise from the forcing influence of heat within an enclosure—a fact well known to all gardeners who force vegetables and fruits, but which injures the quality of the grain in comparison with open fields.

5588. From this known fact it has been alleged that confined fields produce greater evaporation by the confined heat in them, and thereby superinduce an unusual depression of temperature. This must be a theoretical objection, for it is obvious that evaporation will be much more promoted by exposure to the wind than by confinement within fences.*

5589. As one object of enclosing land is protection to plants, whether trees, grains, vegetables, or grass, against the depredations of men and animals, or a protection to and place of confinement for domesticated animals, the use and necessity for enclosures could only have been felt after mankind had made considerable progress in the culture of land, and experienced the consequent depredations committed upon crops. During the pastoral state of society, when men wandered about in communities, and made a fixed abode at one place only as long as pasture could be obtained for their flocks and herds, they tended their stock night and day around their own habitations. Where pasture was plentiful, they pitched upon a convenient spot for themselves, and constructed an enclosure to confine their stock in during the night. The enclosure served the double purpose of relieving the night-watches of the shepherds, and of protecting the stock against the attacks of wild animals. The ground nearest their dwellings was first cultivated for grain. No enclosure was thought of for protecting the grain crops, as long as the stock were tended by day and folded by night. In time, however, as the community increased in numbers, culture encroached upon the range of pasture, which, in consequence, became more scanty. The stock became urgent for food, whilst the tending of them became more difficult as the shepherds engaged in cultivation. A fence then was requisite around the cultivated ground, to fend off the predacious attempts of the stock. Hence the probable origin of enclosing cultivated land.

5590. This view explains the particular mode of enclosing land, once distinguished by the name of *infield* and *outfield*, which prevailed in this country until a late period, and may yet be seen on the Continent in full practice. The distant part, which was solely appropriated to pasturage by the stock, was called the *outfield*. The nearer portion of the land, which bore the grain and vegetables for the cultivators and their families and dependents, and the fodder for the cattle in winter, was called the *infield*. Cultivation was never practised on the outfield, nor were the stock ever permitted to enter the infield. In this way a very strong line of demarcation was drawn betwixt the occupations of the shepherd and the husbandman, which is maintained even to this day. It was partly on this account, perhaps, that the agricultural Egyptians held "every shepherd an abomination" unto them.

5591. The broad distinction then established, betwixt the rearing of stock and the culture of grain, served to conceal from cultivators the valuable fact that stock afford great facilities for fertilising the soil. As long as this fact remained unknown, cultivators did not imagine that the food of stock should be raised on cultivated land, and much less that it could be raised most economically in conjunction with their own food. Whenever it was perceived that grain was more productively raised by the meliorating influence of grass on the soil, that grass-land supported more stock when occasionally cropped with corn, and that the exuvia of stock could manure land better than the art of man, the system of outfield and infield was broken up. The ancient ring-fence, that only surrounded the cultivated land, was then removed to the boundaries of the possession, and in its stead were constructed suitable enclosures for the different crops raised in regular succession.

5592. Enclosures were thus constructed on the boundaries of possessions by the most ancient nations. It is probable that the lower part at least of Egypt was never a pastoral country; for the great fertility conferred on its soil by the annual rising of the Nile would render agriculture the first object of the people. Accordingly, we find it recorded as long since as about 2000 years before Christ, Abram went to sojourn in Egypt, during the famine in his own land, where he had many herds and flocks, and was otherwise wealthy in gold and silver.† Extensive canals were formed, to convey the waters of the Nile to irrigate the parts of the country it did not naturally overflow. The condition of Greece in regard to enclosures was exactly as has been described; and from the laws which governed the limits and landmarks of landed property, it is probable that fences were only erected on the boundaries of properties like a ring-fence.‡ The Romans never enclosed their pasture-land to confine their cattle. They planted fences round gardens, orchards, and meadows, and also round parks for the confinement of wild animals; but in other

* Sinclair's *Code of Agriculture*, p. 171.

† *Genesis*, xii., xiii., and xlvii

‡ *Potter's Antiquities of Greece*, p. 155, edition of 1697.

respects their lands were enclosed much in the same manner as by the Greeks, with a ring-fence round the boundary of the farm; and they employed various kinds of fences for this purpose.*

5593. Most of the modern nations of Europe still enclose their land in the ancient method. Property is so much subdivided in France by the extinction of the law of primogeniture, that in at least one half of that country, all to the eastward, no field enclosures are to be seen—a few march stones, a ditch, a row of trees, or particular single trees here and there, marking the boundaries of the small estates.† Throughout Germany, Bohemia, Switzerland, and Spain, enclosures are only found near farm-houses and villages, the bulk of the corn being raised on extensive unenclosed grounds. I have seen a tract of wheat in Bohemia, as far as the eye could reach, without a single fence in sight. In Lombardy the enclosures consist of the ditches which convey the waters of irrigation to the land. On the other hand, the land in Holland and Belgium is so much enclosed with trees and hedges, that in many places the fields seem half choked by them. The same remark nearly applies to the south of England, where much valuable ground is occupied by beautifully luxuriant, but greatly overgrown hedges. Mr John Grant of Exeter states, that he has ascertained by measurement that in Devonshire alone the hedges are sufficient to encompass the whole of England, being 1651 miles, subdividing only 36,976 acres.‡ The high mounds in that county, if extended in line, would reach from London to Edinburgh. The land in Ireland, particularly in the province of Ulster, is also very much subdivided by turf-dykes, which are generally in a state quite unfit to confine live-stock. It is only in the north of England and the best cultivated districts of Scotland, that enclosures, suited to the improved state of agriculture are to be found. There, farms are not only completely enclosed, but the size of the enclosure is made proportionate to the uses to which the soil is applied. There, growing crops of all kinds find shelter from the vicissitudes of the weather, and protection against animals; and the live-stock themselves enjoy peace and plenty, as a recompense for confinement.

5594. Another object in enclosing land is to afford shelter to plants and animals against the changes of weather. That a fence affords shelter must be a fact cognisant to every one. Feel the warmth of a walled garden—the calm under the walls of even a ruin, compared to the howling blast around—observe the forward grass, in early spring, on the south side of a hedge compared to that on its other side—and listen to the subdued tone of the wind under a shed to its boisterous noise in the open air. Sensibly felt as all these instances of shelter are, they are but isolated cases. In more extended spheres, cottages stand in a calm in the midst of a forest, come the wind from whatever quarter it may. Farm-steadings lie snug under the lee-side of a

hill. Whole farms are unaffected by wind when embayed amidst encircling hills; and be the means of shelter great or small, the advantages derived from them are sensibly felt. As an instance of the benefits of shelter afforded by even a low wall to a park, from the cutting effects of the sea air, fig. 450, on the opposite page, shows you one on the estate of Gosford, belonging to the Earl of Wemyss, in East Lothian, better than words can express. The wall, and the wood immediately behind it, are of the same height; but in a few yards only inwards, the wood rises to a considerable height, which is effected by a simple contrivance, namely, the peculiar form of the cope of the wall. It is raised like an isosceles triangle, by which the wind, when it beats against its side, is reflected upwards into the air at the same angle. Had the cope been flat, the blast would have cut off the tops of the trees in a horizontal direction. But without the wood such a form of coping would afford similar shelter. Supposing land exposed on the top of a high coast, where the wind generally sweeps along the surface of the ground, injuring every plant it blows against, by a momentum acquired in passing over miles of ocean; were a wall built on the top of the crag, at a proper distance from its brow, and of a proper height, having a cope at the angle referred to, it would deflect the wind upwards, and cause it to lose most of its momentum before it again reached the ground. Such a wall, or such a belt of wood, or such a plantation without a wall, if projected on a large scale, and planted near the top of a sloping precipice, or other rising ground, would shelter a large extent of country against the prevailing winds; and were such barriers placed in lines, in suitable situations, across the country, not only its local, but its general climate, would be greatly ameliorated.

5595. Instances are not wanting to prove the advantages derivable to stock and crop from shelter. The benefits derivable from plantation are far more extensive and important than those from stone walls, in improving land. "Previous to the division of the common moor of Methven (in Perthshire) in 1793," says Mr Thomas Bishop, "the late venerable Lord Lynedoch and Lord Methven had each secured their lower slopes of land adjoining the moor with belts of plantation. The year following I entered Lord Methven's service, and in 1798 planted about 60 acres of the higher moor-ground, valued at 2s. per acre, for shelter to 80 or 90 acres set apart for cultivation, and let in three divisions to six individuals. The progress made in improving the land was very slow for the first 15 years, but thereafter went on rapidly, being aided by the shelter derived from the growth of the plantations; and the whole has now become fair land, bearing annually crops of oats, barley, pease, potatoes, and turnips; and in spring 1838, exactly 40 years from the time of putting down the said plantation, I sold 4 acres of larch and fir (average growth) standing therein for £220, which,

* Dickson's *Husbandry of the Ancients*, vol. ii. p. 330. + Young's *Travels in France*, p. 392.

‡ *Journal of the Agricultural Society of England*, vol. v. p. 424.

with the value of reserved trees, and average amount per acre of thinnings sold previously, gave a return of £67 per acre."* On the sum-

mit of Shotley-fell, 16 miles W. of Newcastle-upon-Tyne, Mr Burnet of Shotley-bridge enclosed 400 acres of moorland with high stone

Fig. 460.



THE SHELTER AFFORDED BY EVEN A LOW WALL AGAINST A CUTTING BLAST.

walls ; and he cropped the ground in an easy manner for the soil. The land was thus kept in good heart, but the soil being very poor, stock advanced but little, and consequently the land would not have let for above 6d. an acre, even under the best management, and after all that had been done for it ; but the central part of each field was put within a plantation, and the improvement was then surprising. The cocks-foot grass grew three or four feet high, and the young cattle were four times the stent they were before the land was planted.† Besides affording shelter, plantations beautify the appearance of the country. "The plantation of Muirton in Ross-shire," observes Mr Mackenzie, "has already, in 1836, and will yet in a greater degree improve the climate of the surrounding district,

as well as afford shelter and warmth. Already the plantations relieve and delight the eye, and spread a beauty and freshness around the scene. Muirton formerly looked a bleak and barren wild, while the opposite highly cultivated estates of Brahan and Coul were the delight of every passing traveller ; but with these it may now vie both in riches and beauty. The hill of Muirton as a pasturage was not worth 6d per acre, whereas, by the expending of a small sum, it may be expected to realise from 15s. to 20s. per acre of yearly rent, from the date of planting, even at the distance of eight miles, as Muirton is, from the shipping-places of Beaully and Dingwall. Besides the price of the wood, the value of the enclosure as a wintering for sheep will be considerable."‡

* *Quarterly Journal of Agriculture*, vol. xi. p. 327.

† *Ibid.*, vol. xii. p. 51.

‡ *Prize Essays of the Highland and Agricultural Society*, vol. iv. p. 843.

ON THE PLANTING AND REARING OF
THORN-HEDGES.

5596. The permanent fences of fields in this country are constructed of only two materials, thorn hedges and low dry stone walls. In places, turf walls are formed for permanent fences; but they are only nominally permanent, and unless protected themselves, are easily breached by every kind of stock. They will stand some years with a plantation one side, and protected by a deep ditch on the other; but even then they are only an obstacle, and, at best, a temporary but not permanent fence. A species of permanent fence has of late years been introduced in the wire-fence, which, however, from the nature of the materials, cannot be deemed a permanent fence. There are various temporary fences, as palings, hurdles, nets, dead hedges, and a combination of two or more of these, which are all useful in their respective places, but not as forming permanent boundaries to fields, and much less to an estate. I shall first treat of thorn-hedges; and as different operations connected with them are done in different seasons, I shall take them in the order of their seasons.

5597. *Winter.*—Winter is the most proper season for commencing the planting of thorn-hedges, immediately after the fall of the leaf in autumn; and the operation may be conducted through the winter even to April, when the weather is favourable—that is, when there is no snow upon or frost in the ground, and the soil not wet with a great fall of rain, so as to poach the ground when it is worked. Moisture in the ground is requisite for the proper formation of the hedge bed and bank, and therefore thorns cannot conveniently be planted in summer, or in dry weather in spring. But although the season of planting may be extended to so late a period of the spring as April, the young hedge will thrive the better the sooner it is planted in winter.

5598. The ground should be prepared for the reception of the plants. The usual state of the ground chosen for planting is on lea, and I believed it the best myself at one time; but experience has since shown me that the grass grows upon the face of the ditch, and even through the inverted turf, up amongst the young plants, much to their

injury. The ground should be bare-fallowed, cleaned thoroughly of all weeds, limed early, and manured about a month or six weeks before the planting commences, in the same manner and order as these operations are performed upon bare-fallow land, (4164.)

5599. On commencing the enclosing of an entire farm, the longest lines of the fences should be staked off, and endeavours made to fence those fields first which are to be fallowed, so that when they come into grass the palings may be put up for the use of the grass and the fences at the same time, and thus save the temporary fencing for the grass alone. In the case of one or two fences of a single field being only required, the ground should be fallowed, whatever crop the field may be under; but it is evident that, if the ground to be occupied by the hedge is fallowed along with the field which is to be fenced, or the one adjoining it, the operation will be executed more easily, and at less expense than by itself. The longest lines will run E. and W., that direction being the length of the fields; and when one long line E. and W., and another at right angles to it, N. and S., near the centre of the farm, are staked off, the others will afterwards be set off with comparative ease from both sides of these lines. The base line is the one that runs N. and S. as that is the direction the ridges are considered best to take, and was determined in (5572.) and should be first staked off; and the E. and W. line is set off at right angles to it.

5600. The N. and S. base line is best set off with a pocket compass, allowing for the variation of the needle, which in this country at present is about 27° W. The meridian line might be marked off by the shadow of a pole at mid-day upon the ground, by the watch; but as no sun may appear when you are desirous to prosecute the enclosing, the compass is the surest guide. The lines are set off with feering poles, fig. 18; and the right angles of one line to another by an optical square, which costs 21s., or by a cross-table, which may be purchased for only 7s. 6d. The fixed length of the lines are most easily measured with a good tape-line.

5601. A land-measuring chain will, of course, answer also for this purpose, but it

is not so convenient as a tape line, which is easily rolled up and kept in the pocket. Such a line of 66 feet in length costs 6s. 6d. The best constructed chains I have seen are those made by Mr Thomas Gorrie, wire-work manufacturer in Perth, which consist of oval rings, instead of circular, and of three rings instead of two between the links. Three rings do not catch into one another as two do; and when of the oval form, they are not nearly so apt to stretch as when circular. With brass handles, such a chain costs 14s.

and on the point being known whence the fence is to run E. and W. at right angles to it, the cross-table is placed on it; and having got the line of poles in the N. and S. line of fence through the sights of one arm of the table, the sights on the other arm will direct the line of fence, which is fixed by setting up other poles. Before taking out the poles from the one line, drive stakes in the line to preserve its direction; and after the other line has been straightened by the poles, drive stakes in it also for the same purpose.

5602. The compass indicating the meridian line by setting up one pole at one side of it, and another in the direction of the needle, the line of fence can be drawn straight by means of the feering poles;

5603. If it be desired to set off a parallel line of fence at that time, or at any future time before the thorns are planted, let three poles *c*, *d*, and *e*, fig. 451, be set up in the line of the fence, and let the cross-

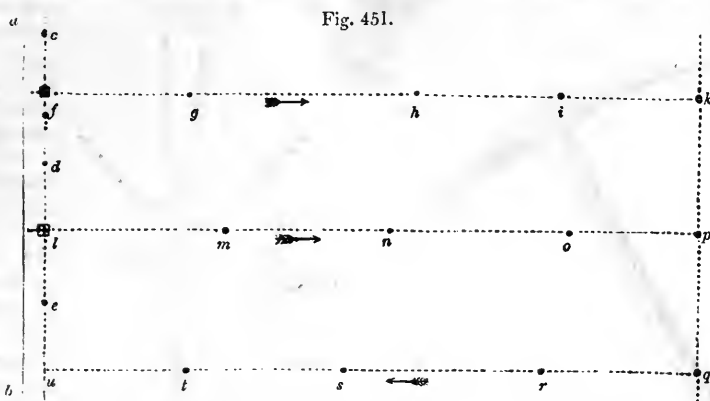


Fig. 451.

THE PLAN OF SETTING OFF FENCES PARALLEL TO EACH OTHER.

table be placed near *f* in the line between *c* and *d*. Let *g*, *h*, and *i* be poles set and adjusted to one another by the cross-table in the line *f k*, at right angles to *c u*, *f k* being the breadth of the field, which distance is measured by the tape-line or a chain so as to contain an even number of ridges of given breadth; because, a fractional part of a ridge, or a whole ridge left at either side of the field, after it has been ploughed will prove inconvenient for work. In like manner, let the line *l p* be drawn from the cross-table placed at *l*, by setting the poles *m*, *n*, *o*, *p*. Then set a pole at *q* in a line with the poles *p k*, and measure the distance betwixt *q* and *u*, along the line *r s t*, with the tape; which distance, if the two previous operations have been accurately conducted, should be exactly equal to the distance betwixt *f* and *k*, and *l* and *p*; but should it

prove greater or less than either, some error must have been committed, which can only be rectified by doing the operation over again. The arrows show the directions in which each line should be measured. Great accuracy should be observed in running these lines of fences parallel, for if they are not so at each successive line of fence, the deviation will prove very considerable betwixt the first and last lines. Three poles only are employed to set off the lines *f k* and *l p*, the ground being supposed to be nearly level; but wherever from an inequality of ground you lose sight of one of the poles, as many more should be employed as to have three always in view at one time. When a new line of fence is desired to be set off parallel to an old one, the line *a b* represents the old fence, and the cross-table is placed at about six feet

in the line *cu* parallel to it, to afford room for the observations.

5604. Before the line of fence can be begun to be planted with the thorns, certain implements are required for the work: A strong garden line at least 70 yards in length, having an iron reel at one end, and a strong iron pin at the other: its use is to show, upon the ground, the exact line of the fence betwixt the stakes. It costs 4s. A few pointed wooden pins, with hooked heads to keep the line steady, whether in a straight line or in a curve. A wooden rule, 6 feet in length, divided into feet and inches, having a cross-head of about 2 feet in length, nailed at right angles to it: its use is to measure off short distances at right angles. No. 5 spades, fig. 237. An iron tram-pick, fig. 247. A hand-pick, fig. 452.

Fig. 452.



A HAND-PICK.

Fig. 453.



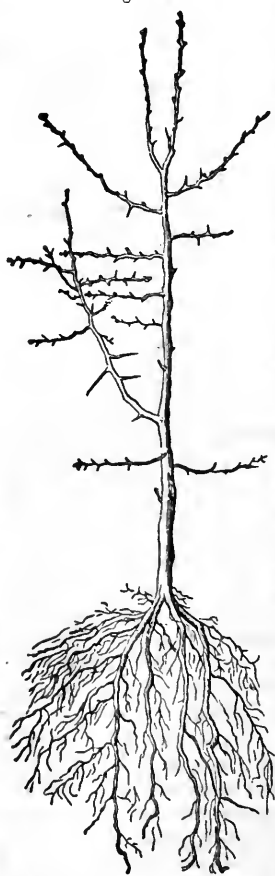
A DITCHER'S SHOVEL.

It is 18 inches long in each arm, and 3 feet long in the helve. It costs 5s. 6d. or 6s. A sharp pruning-knife to each man, to prepare the thorn plants with: it costs 2s. or 3s. A ditcher's shovel, fig. 453: its use is to clean out the bottom and sides of the ditch, and to beat the face of the hedge-bank. Its face is 1 foot broad and 1 foot long, with a tapering point, and its helve is 28 inches in length. It costs, No. 5, 4s. This is a useful shovel on every farm for cleaning up the bottoms of dunghills in soft

ground—much better than the square-mouthed shovel, fig. 83; and yet in some parts of the country it seems quite unknown.

5605. The *plant* usually employed in this country, in the construction of a hedge, is the common hawthorn. "On account of the stiffness of its branches," says Withering, "the sharpness of its thorns, its roots not spreading wide, and its capability of bearing the severest winters without injury, this plant is universally preferred for making hedges, whether to clip or to grow at large."* The thorn thus possesses all the characteristics of a plant well suited to make a good fence. Thorns ought never to be planted in a hedge till they have been transplanted at least 2 years from the seed-bed, when

Fig. 454.



A GOOD THORN PLANT.

they will have generally acquired a girth of stem at the root of 1 inch; a length in all of 3 feet, of which the root measures one foot, as in fig. 454, which is on a scale of $1\frac{1}{2}$ inch to 1 foot. Picked plants of that age are 12s. 6d. per 1000; or, as they are taken out of the lines, 10s. 6d. As thorns are always transplanted too thick in the nursery lines, to save room, and draw them up sooner to tall plants, I would advise their being purchased from the nursery at that age, the year before they are in-

* Withering's *Botany*, vol. iii. p. 561.

tended to be planted in the fence, and laid in lines in garden mould, or deep dry soil. By this process the stems will acquire a cleaner bark and greater strength, and the roots be furnished with a larger number of fine fibres, which will greatly promote the growth of the young hedge, and repay the additional trouble bestowed on the plants. But when the plants are not so treated before they are planted, the bundles, containing 200 plants each, should be immediately loosened out on their arrival from the nursery, and the plants *sheughed in*,—that is, spread out thin and upright in small trenches in a convenient part of the field, and in dry earth well-heaped against them, to protect the roots from the frost, and to keep them fresh until planted. The plants are taken from the *sheughs* when wanted.

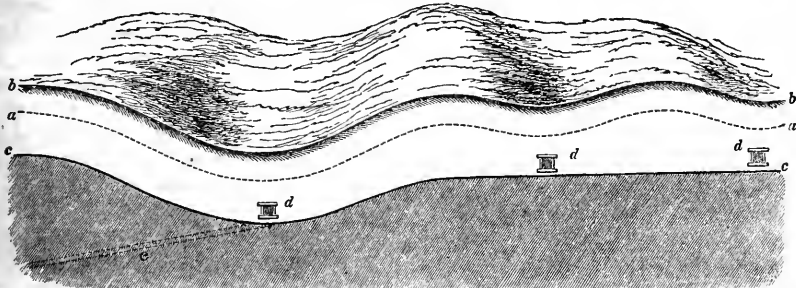
5606. With all the materials provided, the workmen must also be engaged. The number of men required to plant a hedge is three—one, the hedger himself, and two assistants, who have each his duty to perform, and should be kept at it without

change of arrangement. When fewer hands are employed, the men must change from one portion of the work to another; and when more, one will at times be comparatively idle. The work never goes on so well, or so regularly, as when each takes and keeps by his own particular part of the operation.

5607. There is nothing peculiar in the dress of the hedger, except in his shoes. In winter, he should always wear clogs, having soles of wood, with upper-leathers, and shod with iron on the sides and sole, for an easy tramp upon the spade and foot-pick. Such clogs cost about 5s. per pair.

5608. The ground along which the line of hedge is proposed to be planted should be surveyed before a commencement is made from the starting point, and if the surface is uniform and level, the work may proceed at once; but should heights and hollows intervene, preparations must first be made to convey away the water that might stand in the hollows after the hedge has been planted. Fig. 455 will

Fig. 455.



PLAN TO PREVENT WATER LODGING IN THE HOLLOW, BEHIND THE BANK OF A HEDGE.

convey an idea of what I mean, in which is represented the inequalities on the surface of the ground; and although these seem close together in the figure, they may be supposed in reality to undulate in considerable distances. The parts of the figure are these: *a a* is the line of hedge; *b b* the top of the hedge-bank, parallel to the hedge; *c c* the bottom of the ditch, exposed to view by the removal of this side of the ditch, as also the conduits *d d d* for conveying the water from behind the hedge-bank *b b*; *e e* is a covered drain from the bottom of the ditch, at the lowest point of the lowest hollow. Where the hollows in the ditch are only separated by a small

rise in the ground, the bottom should be made deeper in the rising-ground, to let the water run to the lowest point, that one drain may convey away as much water as is practicable. The conduits, in all such cases, should be founded as low as the bottom of the ditch to be taken out, having a sole, sides, and cover built of stone; and the area of the conduits should be made to contain the largest quantity of water that will ever flow through them. The ground behind the hedge-bank *b b* is represented as falling towards the hedge. To prevent the under-water percolating from this ground to the hedge, a common drain should be made in the hedge

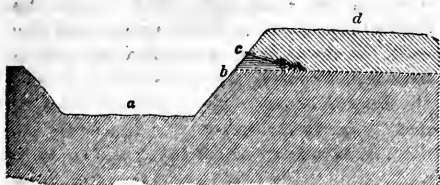
about three yards behind the hedge, at least 4 feet deep, and filled with drain-tiles, and its outlet made to discharge itself in the hollowest point to reach the drain *e*, or elsewhere, if more convenient and efficient. A conduit of dry stones, having an opening of 16 inches in height and 12 inches in breadth, with sole and cover, will cost in building 1s. 6d. per rood of 6 yards.

5609. If the line of fence is to be straight—which should always be the case, if natural obstacles do not interfere to prevent it—let the poles be set up in as straight a line as possible, from one end of the fence to the other. Should the surface be level, this line can be drawn straight with the greatest accuracy; but should elevations and hollows intervene, however small, great care is requisite to preserve the straightness of the line, because the rising parts of the ground are apt to advance upon the true line, and the hollows recede from it, especially when the inequalities are abrupt. Surveyors use the theodolite to avoid this error, but it may be avoided by using plenty of poles to be set not far asunder from one another. In case evil-disposed persons should shift the poles in the night, and thereby alter the line of fence, pins driven in, at intervals, into the ground, will preserve the line. Having set plenty of poles, so as to please the eye, take the reel and cord, and, pushing its pin firmly into the ground at the end of the line of fence where you wish to begin, run the cord out its full length, with the exception of a small piece to twist round the shank of the reel. Be sure to guide the cord exactly along the face of the poles at the bottom; and should any obstacle to your doing so lie in the way—such as clods, stones, or dried weeds—cause them to be removed, and the ground smoothed with the spade; and then, with your face towards the cord, draw it towards you gradually, with considerable force, until it has stretched as far as it can, and then push the shank of the reel firmly into the ground. As the least obstruction on the ground will cause the cord to deviate from the true line, lift up the stretched cord by the middle about 3 feet from the ground, keeping it close to the faces of the poles, and let it drop suddenly to the ground, when, by its elasticity it

will probably lie as straight as practicable. Place a rather heavy stone here and there upon the cord, to prevent the possibility of its being shifted from its position. With the common spade then *rut* the line of hedge-bed behind the cord, with your face towards the ditch that is to be, taking care to hold the spade with a slope corresponding to the side of the proposed ditch, and not to press upon, or to be too far back from, or cut the cord. Then take the wooden rule, and placing its cross-head along the cord, set off the breadth of the ditch at right angles to the rutted line $4\frac{1}{2}$ feet—first, at both ends of the still stretched cord, and then at intervals; and mark off those breadths with wooden pins, which will serve to check any important deviation from the true line along the length of the cord. Now, take up and stretch the cord anew along this other side of the ditch, by the sides of the new-placed pins, in the same manner, and with the same precautions as with the hedge-bed; and rut the line with your face towards the ditch, sloping the spade to the inclination of its side. After marking out the ditch thus, secure the continuation of the line of the fence by means of the standing poles, and then remove them and the pins along the new length of the cord. The ditch thus marked out is ready for the formation of the thorn-bed. When about forming the thorn-bed, that end of the line should be chosen for commencing the work which best suits the hand of the workman who is intrusted to make it. The rule for this is, whichever hand grasps the eye of the spade should be nearest the thorn-bed, and the workman should work backwards. The ordinary practice is to take the eye of the spade in the left hand.

5610. In forming the *thorn-bed*, raise a large, firm, deep spadeful of earth with the common spade, from the edge of the ditch next the line of hedge, and invert it along that line, with its end towards the ditch. Having placed a few large spadefuls in this manner, side by side, beat down their crowns with the back of the spade, paring down their faces in a line of the slope given to the first rut, and then cut back their crowns with an inclination downwards and away from you, forming an inclined bed for the thorn-plant to lie upon, as shown by the angle subtended

by the line *c b*, fig. 456. In like manner
Fig. 456.



THE THORN-BED.

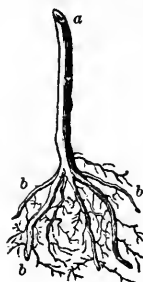
place other spadefuls at the end of those last laid down, taking care to join all the spadefuls so as to make one continued bed, as above described, and to proceed thus along the length of the cord of 70 yards.

5611. Whilst the hedger is thus making the thorn-bed, his two assistants prepare the thorn-plants for planting. The plants are assorted, according to their sizes, as they are picked out of the bundles made up as they were taken from the transplanted lines, recommended in (5605.) the advantage of which is, that the plants are thereby suited to the situation they occupy. On examining the plants, they will be found to be both stout and weak. The stoutest cannot derive sufficient nourishment in the thinner and poorer class of soils, however well it may have been prepared for their reception; whilst the weak ones will thrive well in good soil. From this statement, it might be concluded that weak plants are best adapted to all classes of soils. Not so; for however well weak plants may thrive in good soils, stout plants will grow much better than weak in all soils; and were the soil all good, the most profitable fence would be obtained from the best and picked plants. But as every farm possesses soils of various degrees of fertility, although the class of its soils may be the same, and as plants in a stout and weak state are usually mixed together, the most prudent practice is to put the weaker plants in the best soil, and the stouter plants in the worse kind of soil, thus giving a chance of success to both sorts of plants and soils; or else reject the weak plants altogether, which would enhance the cost of the plants. One means of rendering the weak plants strong, is in transplanting them in good soil, and allowing them to remain in it until they have acquired sufficient strength to be planted out. Want of

attention to these adaptations of means to ends is one cause of failure in the rearing of thorn-hedges.

5612. The prepared thorn-plant is represented by fig. 457; and it is prepared in this way. After removing a number of the small branches with a knife, grasp the stem of the full plant, fig. 454, immediately above the root, firmly in the left hand, and cut it across beyond the hand, with a sharp knife, with an inclination towards the top of the plant as at a fig. 457; and the cut

Fig. 457.



A THORN-PLANT, PREPARED FOR PLANTING.

thus made will be about 6 inches above the root and fibres. Cut away the long points of the tap-roots *b b b*, and any other straggling and injured roots, and even injured fibres; but preserve as many of the fibres entire as possible. Burn the tops thus cut off, or bury them deep in the ground; as they easily vegetate, and are quickly blown about by the wind, and become a great annoyance to sheep in the wool. Take great care, in frost, to cover up the prepared roots in earth until they are actually planted, for if the roots are in the least affected by frost they will not vegetate. The safest plan, in frosty weather, however gentle, is to take but a few plants at a time out of the lines. In dry weather in spring, put the roots of the prepared plants in a puddle of earth and water, in a shady place, for some hours before laying them in the thorn-bed, and their vegetation will thereby be much quickened.

5613. When both the thorn-bed and plants are prepared, the assistants lay the plants in the bed. This is done by pressing each plant firmly into the mould of the bed at *c*, fig. 456, with the cut end of the stem projecting not more than a quarter of an inch beyond the front and upper edge of the thorn-bed, and with the root-end lying away from the ditch, at distances varying from 9 to 12 inches—the 9 inches being adapted to inferior land, and the 12 inches to good soil. Whilst the two assistants are laying the plants, the hedger

takes up all the finer part of the mould, nearest the thorn-bed with the ditcher's shovel, fig. 453, and dexterously inverts it above the laid plants, securing them in their places with a few pats of the shovel. The two assistants should not lay more thorns than can be entirely covered with soil before evening, and, having finished laying them, they follow the hedger, and dig and shovel up with the spade all the black mould in the ditch, throwing it upon the roots and stems of the plants, until a sort of level bank of earth is formed over them, as at *d*, fig. 456. In doing this, one of the assistants lifts all the soil across the breadth of the ditch, at *a*, working backwards; whilst the other works forwards, face to face, shovelling up all the black mould he can find, whether in a loose or firm state, in the ditch. When the hedger has finished covering the plants with mould, and whilst the assistants are proceeding to clear all the mould from the ditch, he steps upon the top of the mound which they have thrown up above the plants, and, with his face towards the ditch, firmly compresses, with his feet, the mould above the plants.

5614. When any manure is proposed to be given to the thorn-plant at this stage of the operation, the time to apply it is after the hedger has laid the soil above the plants, and before the larger portion has been put on by his assistants. The manure should be well prepared, and as much granulated as possible, to mix intimately with the soil, which should be prevented subsiding, for if it crack by that during winter, the frost may enter to the injury of the plants. While the hedger is compressing the mould, his assistants straw the manure over the compressed soil.

5615. By the time he has finished the compression, all the mould will have been taken out of the ditch by the assistants. When no manure is applied at this time, and after the soil has been fallowed and dunged in the autumn, this is a good time to apply lime. When the thorns have received this quantity of earth above them, and the lime covered with a sprinkling of earth, the plants may be considered in a safe state from the frost; but it is not safe, in frosty weather, to leave them even for a night, with *less* earth upon them—for plants may not only be frosted in that short

space of time, but the earth may be rendered as hard by frost as to be unfit for working the next day; and should the frost prove severe and continuous, and the work be altogether suspended, the plants thus left exposed will inevitably perish. In frosty weather the plants should be laid on the thorn-bed only in the forenoon, the afternoon in winter being too short to allow time to lay plants, and to cover them too with a sufficient quantity of earth. In such weather it is better to leave off work altogether, for the frosted earth will chill the tender fibres. When the weather is fresh, and not too wet, the plants may be laid in the afternoon in spring. In wet weather the work should also be suspended, not only on account of the cloggy state of the ground for good work, but the impropriety of the men withstanding much rain in winter. The finishing of the top of the hedge-bank will be more uniform, and look better, when a considerable length is finished at the same time, than when joinings are visible at short intervals; but in frosty or in wet weather, the sooner a piece is finished, the better for the cleanliness of the labourers and the condition of the soil.

5616. The rule observed for the depth of a ditch that stands well is one-half its breadth, and the width of the bottom one-sixth of the breadth at the top. In the case of hedge-planting, the breadth is 4 feet; the depth is therefore 2 feet 3 inches, and the width of bottom 9 inches. The hedge-bank is always broader than the ditch, being about 5 feet, the soil lying loosely upon it; and the perpendicular height of the bank is less than the depth of the ditch, being 2 feet. These are, in general, convenient dimensions for a hedge ditch and bank, where no constant run of water has to be accommodated in the ditch; but should there be, though in winter only, it should be made proportionably capacious; for, if not, the water will assuredly make it so, to the danger of the thorn-bed. Ditches brought to a point at the bottom are objectionable for many reasons. They do not afford sufficient materials to form a mound for the young thorn-plants; they are easily filled up with the mouldering of earth from the sides, and the decay of vegetables; and when water gets into them, the bottom

either soon gets filled up with mud, or is deeply guttered.

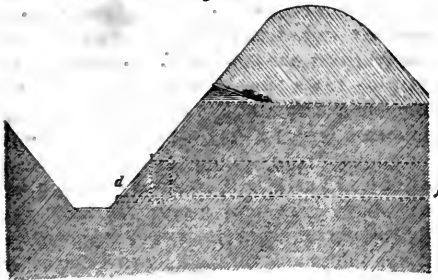
5617. When the work has proceeded thus far, the other implements come into use. If the subsoil of the ditch is a tenacious ductile clay, the spade alone is the best to remove it, as it is useless picking such a substance, especially if somewhat moist, as no more will rise at a time than the breadth of the face of the pick. But if it consists of hard dry clay, interspersed with veins of sand and gravel—which compose a very common subsoil in this country—picking is absolutely necessary, and the spade can make nothing of it. In some parts of the country the handpick is alone used to loosen subsoil, whilst in others the footpick is employed; and, from experience in both, I recommend the latter as being the more efficient implement for such work, and less laborious to the workman. Let one of the assistants loosen the subsoil with the footpick, fig. 247, as deep as he can go for the tramp, working backwards, and using it as directed in (3149.) When the picker has thus proceeded a short way, the other assistant lifts up with his spade what has been loosened, and throws it upon the top of the mould above the thorn, upon *d*, fig. 456, taking care to place the subsoil so thrown up continuous with the slope upwards given to the face of the bank. He also throws some on the back of the bank, to cover the whole of the black mould with the subsoil, and endeavours to make the shape of the bank uniform. In doing all this, he works backward, with his back to the face of the footpicker, and standing upon the subsoil which has been loosened by the footpick, though his back would be to the back of a handpicker. He pares down the side of the ditch nearest his right hand, which, in this case, is the opposite one from the hedge. The hedger follows this last assistant, working towards him face to face, and moving forwards, shovelling up all the loose earth left by the assistant's spade with the ditcher's shovel, throwing it upon the top and fully upon the front of the mound, rejecting all the larger stones, paring down the side of the ditch at his right hand, and making the bank equal and smooth, by beating the earth upon its face firmly. Should the subsoil require no picking at all, the two

assistants follow one another, using the spade; and the hedger brings up the rear, using the shovel. Should there be more earth at one place of the ditch than another—which will be the case where inequalities abound on the surface—the surplus earth should, either be thrown to the back of the bank, rather than its top, be made higher at one place than another, or wheeled away to a spot where a deficiency of earth will assuredly happen in a hollow. Besides giving the bank an irregular appearance, it is not desirable to cover the young thorns too heavily with a superfluous load of earth, so as entirely to exclude the air and moisture from their roots.

5618. If going along the ditch twice finishes the work, the earth must have been in a friable state; but with a hard subsoil the work is not so easily done. The handpick is almost always used to raise the last 4 or 5 inches of the bottom of the ditch; and in removing the soil the same arrangement of the men is maintained, only that the handpicker works forward. Whilst the assistants are picking and shovelling, the hedger again tramps down the top of the bank, before throwing up the last portion of earth. The poorer the covering of clay is over the bank, it is the better for the purpose to resist the vegetation of small seeds. The beating the face of the bank with the back of the shovel is absolutely necessary to produce a skin to resist the action of the frost, and prevent the mouldering of the earth into the ditch. The necessity for the beating of the face shows the expediency of projecting the plants but a very short way out of the bank, as it might injure the points of the stems. They might be almost buried in the bank, and still the young sprouts will easily release themselves by the force of vegetation. Whilst the two assistants are preparing the cord for another stretch of the fence, and and rutting off both sides of the ditch, the hedger pushes back or makes up two or three inches, less or more, of the crest of the bank with his shovel, to make the finished top parallel with the row of thorns; and after he has gently beaten down the front of the top into a rounded form, the planting of the thorns is finished. Fig. 458 gives an idea in section of the

work when finished. I have introduced into this figure the direction the conduit takes

Fig. 458.



FINISHED HEDGE-BANK.

when formed below and through the hedge bank into the bottom of the ditch, in connection with the subject treated in fig. 455. Here *d f* represents the line of the conduit in section, the outlet of which is seen near the bottom of the ditch at *d*.

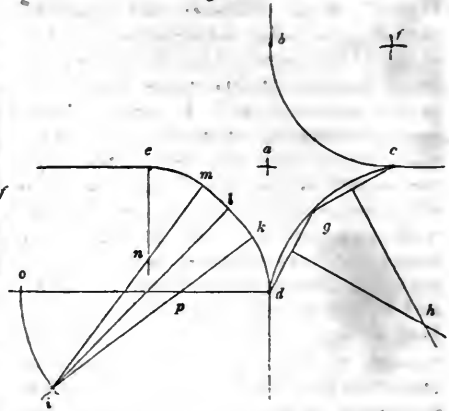
5619. Large boulders will no doubt be found in the subsoil, when it is of clay, most of which may be removed with the footpick, with the assistance perhaps of an iron lever, named a pinch or crow-bar; but the largest ones may be immovable by such means, when gunpowder should be used to rend them to pieces.

5620. In ordinary cases, when two lines of hedges meet, they intersect one another in a point, and at the crossing form a junction of 4 fields by their corners. Should the land not be of much value, or the particular situation be much exposed to the weather, it might be advisable to make a clump of planting of a stellar form at the junction of the four corners. Besides the means of shelter, such a rounding off the corners of fields is useful to their ploughing. It is however, first necessary to ascertain the quantity of ground that can be conveniently spared, although it is not worth while to enclose a smaller space than a quarter of an acre, and the largest space need not exceed one acre in the low country.

5621. Supposing the space is determined, its enclosure is done in this manner: Ascertain the point where the two lines of hedges would intersect, and fix a pole there as at *a*, fig. 459; and from it measure an equal distance with a tape

along each line of fence to the points within which is to be included the space of

Fig. 459.



MODES OF DESCRIBING A CURVE IN THE CORNER OF A FIELD.

ground allotted for the planting, as from *a* to *b*, to *c*, to *d*, and to *e*. An arc has to be described between two of the nearest of those points, and there are three ways of describing them. From *b* as a centre, with a radius greater than half the distance between the points *b* and *c*, sweep an arc at *f*, and from *c* as a centre, with the same radius sweep another arc intersecting the first in *f*; and then from *f* as a centre, still with the same radius, sweep the arc *c b*. In like manner an arc of the same radius may be swept betwixt *c* and *d*, *d* and *e*, and *e* and *b*. This rule gives no pre-determined arch, further than its radius must be greater than half the distance between its extremities, but it is one which presents a pleasant curve to the eye.

5622. Another plan is to fix the height of the segment of the arc, determined by a point, beyond which the hedge shall not approach towards the centre of the ground *a*. This restriction may be necessary in some cases. It is done by at once fixing the point *g*, which gives three points, *d*, *g*, and *c*, through which the arc must pass. Its centre is formed by joining *g d*, which bisect, and from the point of bisection raise a perpendicular; also join *g c*, which bisect, and from the point of bisection raise a perpendicular, and from the point as a centre where the two perpendiculars intersect at *h*, sweep the arc *d-c*, with the radius *h g*. This rule is

founded on a corollary to the 1st Problem of the 3d Book of Euclid.*

5623. A simple rule, which practical gardeners employ in drawing one line at right angles to another, is this : From the given point, measure 6 feet along the line, and from the same point measure outward 8 feet ; from the further end of the 6 feet, measure 10 feet towards the end of the 8 feet, and the point where the 8 feet and 10 feet meet is perpendicular to the given point. This rule is directly founded upon the celebrated 47th Proposition of the 1st Book of Euclid.

5624. The third method is this : Let l be the point intended to determine the curve between d and e , equidistant from each ; then set off the point i also equidistant from d and e , and join il ; from any point on the line il as a centre describe an arc of such radius as shall pass through l , but will fall anywhere within d and e . Draw do at right angles to the fence d , and make do equal to il , then find a point p on the line do equidistant from o and i . Join ip , and produce it towards k , and from p as a centre describe the arc dk , which will touch the larger circle, of which km is also an arc, according to Euclid, 3d Book, 11 Prob. In like manner, the arc em can be described by first drawing en , at right angles to the line of fence e , and proceed as before. If the lines of fence run at right angles to each other, the arcs dk and em will have equal radii. This is too intricate a mode of drawing curves for practical purposes, but it is well that your ingenuity should be exercised in every possible way, that you may never be at a loss to apply expedients according to circumstances. This method, however, enables you to form curves of different sizes, in situations where such may be required on account of obstructions.

5625. In setting poles for straight lines, ordinary accuracy of eye will suffice ; but in setting them in curves, where geometrical ones cannot be introduced, considerable taste is required by the planner. Such curves can only be formed by setting up large pins, and by judging of their beauty by the eye, so that the sweeps may appear naturally to accommodate

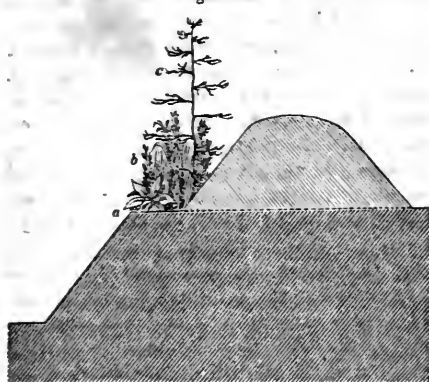
themselves to the inequalities of the ground, and form, on the whole, a suitable figure for the purpose they are intended to serve. Curves in fields should be made conformable to the ploughing of the adjoining land, for, if such adaptation be not attended to, land may be lost to tillage in the acuteness of the curves. After large pins are set to show the general form of a long curve, or series of long curves, smaller ones should be employed to fill up the segments between the larger, which the cord stretched upon the face of all the pins will show, and the beauty of their curves may be preserved by small pins with hooked heads. If a curve on a ditch is required, the rutting of the breadth of the ditch, as also the making of the thorn-bed, should follow the cord in its curved position ; but great care is requisite to preserve the two sides of a curved ditch parallel ; for if the cross-headed wooden rule is not held as a tangent to each particular part of the curve which the ditch is to have, the breadth of the ditch will vary considerably in different places, and its form will be twisted. The hedge-bank will then be deprived of sufficient covering at places where the ditch is twisted into broad and narrow portions. There is no error into which labourers are so apt to fall as this : they measure, without thinking of the consequences, at any angle across a curved ditch.

5626. A very common practice—recommended by most writers on hedges—is to leave a broad scarcement in front of the thorn-bed, because it is necessary to supply the young thorns with moisture. It is alleged that the sloping face of the bank conveys away the rain that falls into the ditch from the plants. And what although it does ? The young thorn does not imbibe moisture by the point of its stem, but by the fibres of its roots, which easily obtain it through the mould, the earth of which is loose enough for the transmission of rain. But independently of this, a scarcement is evidently so excellent a contrivance for encouraging the growth of weeds, that it is impossible to clean a hedge well where there is one. Earth from the bottom of the ditch may, no doubt, be occasionally thrown upon the scarcement to smother the weeds ; but its accumulation there must be limited to the height of the thorn-bed, and weeds can

* Duncan's *Elements of Plane Geometry*, p. 57.

grow as well upon this earth as upon the scarcement. The appearance of fig. 460 is

Fig. 460.



BAD EFFECT OF A SCARCMENT.

sufficient to condemn the use of the scarcement in any hedge-work, where the weeds *b*, on the scarcement *a*, vie in height and vigour with the thorn plant *c* itself.

5627. Where part of a hedge is desired to be carried across a water-course, an arch or large conduit is often made to span it, its sides banked up with sods or earth, and a quantity of mould wheeled upon it, to form the thorn-bed. I have seen such structures, but do not approve of them, because hedge-banks on stone building do not retain sufficient moisture in summer to support even young thorn-plants. If the nature of the ground will admit of it, it is better to plant the thorns on the surface of the ground, as near as possible on each side of the water-course, above flood-mark. The water-channel, probably dry in summer, when the fields are only used for stock, can be fenced with paling; or, what is a better fence, if stones can be procured at a reasonable distance, a strong dry-stone wall, with large openings in it to allow the water to pass through in winter. The openings can be filled up in summer with a few thorns, to keep in sheep.

5628. If it is desired to plant a thorn-hedge on the top of a sunk-fence, or along the edge of a walk by the side of a shrubbery, or to enclose a shrubbery or a clump of trees in pleasure-ground or lawn, the plants should be assorted and prepared as directed above (5611); but instead of raising a mound, which in such situations would

not look well, trench a stripe of ground with the spade, in the intended line of the hedge, at least three feet in breadth, pointing in dung and raking in lime in adequate quantities some time before the period of planting. When that time arrives, stretch the cord in the middle of the stripe, guiding the curves with wooden pins. First, smoothen the surface of the ground with a clap of the spade upon the cord, and then notch deeply with it by the side of the cord, drawing the earth towards you. Into this furrow carefully place the roots and fibres of the thorn-plants, with their cut stems, fig. 457, leaning against the cord; and, supporting the plants in their places with the left hand, fill up the furrow with earth with a trowel in the right hand. Press the plants firmly against the earth with the outside of the foot placed in a line with the stems, and fill up and make the surface level with the spade. After the removal of the cord, press the ground with the row of thorns between both your feet, and finish off the work with a rake. In planting ornamental hedges, you should bear in mind that, for whatever purpose a hedge may be wanted, the thorns should always be planted on the natural surface of the ground; for if set in travelled earth, unless it is of considerable bulk and depth, they run the risk of being either stunted in growth, or of altogether perishing for want of nourishment. Thorns might be planted in this manner in the fields, and where the soil is deep and dry the plan is good, and the plants will no doubt thrive; but in shallow soils, however dry—and especially where they are damp below—even though drained, the plants will most probably not thrive. I observe that most of the thorns planted along the sides of railways, for fences, are planted on the surface; but time is yet wanting to show whether or not they will thrive in all cases. I suspect they will not, for draining is very imperfectly attended to on railways.

5629. Forest trees ought never to be planted in the line of thorns, for it is quite impossible, even with the greatest care, to rear thorn-plants, to become a good fence, under their drip. Thorns are very impatient of being overshadowed by taller trees; and trees planted on the top of a mound, betwixt double hedges, not only

rob both of moisture at the roots, but pour their drip directly upon branches of the thorns. "To plant trees in the line of a hedge," says Lord Kames, "or within a few feet of it, ought to be absolutely prohibited as a pernicious practice. It is amazing that people should fall into this error, when they ought to know that there never was a good thorn-hedge with trees in it. And how should it be otherwise? An oak, a beech, or an elm, grows faster than a thorn. When suffered to grow in the midst of a thorn-hedge, it spreads its roots everywhere, and robs the thorns of their nourishment. Nor is this all: the tree, overshadowing the thorns, keeps the sun and air from them. At the same time, no tree takes worse with being overshadowed than a horn."* Hedgerow trees are strongly recommended, by all the old writers on agriculture, as being the best means of growing timber for the navy, and giving shelter to fields; and even a recent writer on timber seems to favour the plan of planting the oak in hedgerow, as if that tree could not be sufficiently gnarled for naval purposes, and rendered thick in the bark for tan, in other exposed situations where they could do no injury, rather than in thorn-hedges.†

5630. Where thorns are made to fence plantations, they should be planted on the outside of the mound, though facing the N., that the air may have free access to them; and no large forest-tree should be planted near behind them.

5631. It is not unusual to see beech mixed with thorn as a hedge; but beech is nowhere a terror to live-stock in fields. The sweet briar (*Rosa canina*), too, is frequently mixed with the thorn, and no doubt imparts a delightful perfume to the air after a shower in summer; but it soon overcomes the thorns near it. The crab apple (*Pyrus malus*) also displaces thorns in hedges. We have only to view the hedges in the southern counties of England, to be convinced of the noxious effects of intermixing other plants with the thorn.

5632. *Spring*.—Our attention has been occupied with the fencing of a whole farm with thorn hedges; and such an operation

can only be undertaken in winter. Now that spring has arrived, when the planting in all cases should cease, we have to attend to the treatment of hedges of older growth, and the first consideration bestowed on them in spring is *pruning*. The season of pruning is limited, for it ought not to be begun as long as frost is likely to occur; nor continued after the sap has become active in the plants in spring. I remember of a fine hedge in Berwickshire being breasted over, in a time of hard black frost, not so much for its own sake, as to obtain a near supply of thorns for a dead-hedge. I remarked to the hedger that the thorns gave a curious metallic ring on being struck with the hedge-bill; but he was insensible to the peculiarity of the sound where he stood, beside the hedge. Whether this sound was indicative of the subsequent phenomenon exhibited by the hedge, I know not; but the pruned stems put forth very few buds in the subsequent spring and summer—not that they seemed to be dead from the appearance of the bark or of the wood, where the latter was exposed to view by the action of the hedge-bill. The hedge continued in a dormant state in the ensuing winter; but in the following spring, more than twelve months after the pruning, it exhibited signs of life, and put forth most vigorous shoots in summer, some of them not less than 4 feet in length. Although I cannot explain this phenomenon, there is sufficient peculiarity in it to justify the advice, that no hedge should be cut down in winter

Fig. 461.



THE SWITCHING-BILL.

in frost, but to await the return of the sap in spring.

5633. The pruning of well-grown young hedges consists of only one operation—*switching*. Switching is the lopping off straggling branches that grow more prominently from a hedge than the rest; and, in doing this, the extreme points of many of the other branches are also cut off. This operation is performed

* Kames' *Gentleman Farmer*, p. 283.† Matthew *On Naval Timber*, p. 359.

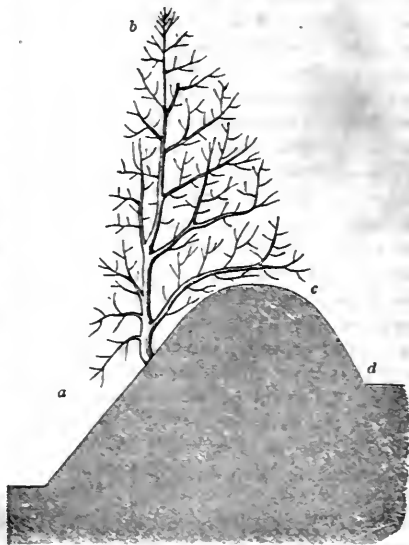
with the switching-bill, fig. 461. It has a curved blade 9 inches long, and $1\frac{1}{2}$ inch broad; a helve 2 feet 3 inches in length; and its weight altogether is about $2\frac{1}{2}$ lb. It feels light in the hand, and is used with an upward stroke, turning backwards over-head.

5634. Hedgers have a strong predilection to use the switching-bill. They will, without compunction, switch a young hedge at the end of its first year's existence. No new planted hedge ought to be touched with a knife until it is at least two years old—the great object being to attain enlargement of the roots, that they may search about freely for support; and the only way a plant has of acquiring large roots is by means of the growth of its branches and leaves in summer, supporting their healthy functions. Even beyond the age mentioned above, the pruning-knife should scarcely be used, until the young hedge has acquired the height sufficient for a fence; and not freely then, but only to check the inordinate growth of some of the branches, and to preserve equality in the size of the plants. There can be no doubt of excessive pruning curbing the growth of the young roots of hedges, when we observe the very puny stems which much pruned young hedges always present. Both experience and observation have satisfied me, that to the abuse of pruning should be ascribed most of the deaths of young hedge-plants, and the consequent number of gaps observable in old hedges. No doubt the thorn plant is placed in a wide range of soil and situation, and it is reasonable to expect that it will grow better in some situations than others; but having had favourable opportunities of observing the rearing of thorn hedges in a great diversity of soils, from the lightest gravel to the heaviest clay—and even in peat-moss—I can affirm that rational management will enable them to become a good fence, and continue so in any soil, though not in any situation, such as amongst under-water. Let the plant have peace to grow till it has acquired a considerable degree of natural strength, taking a longer or shorter time to acquire it, according to the circumstances in which it is placed—acquiring it in the shortest time in deep sandy loam, the most useful of all soils, and taking the longest time in poor thin

clay on a tilly subsoil—in every case let it grow, and let it afterwards be judiciously pruned, and the assurance of experience is, that you will possess an excellent fence, and a beautiful hedge, in a much shorter time than the usual treatment by hedgers will ever produce.

5635. I have given, in fig. 462, a repre-

Fig. 462.



A CORRECTLY SWITCHED THORN HEDGE.

sentation of the average height which a young hedge should attain, in relation to the height of its hedge-bank and the depth of its ditch, before it is switched up; and although all the plants will not, in that time, have individually acquired the strength of that represented in the cut, still the form and outline of the hedge, traced by the letters *a b* and *b c*, may be obtained. This form is given to the plant by switching the face *a* next the ditch with a slight batter towards the top, *b*, which is more perpendicular—more like a walled fence than the face behind, from *c* to *b*—because the plant in that particular part should be encouraged to cover the top of the hedge-bank with its lowest branches, for the double purpose of preventing trespasses upon it, and of keeping down the weeds upon the bank, as also of forming a sloping face from the level of the ground at *d*, to the top of the plant at *b*. A hedge of such a shape will not only

have a broad enough basis from *a* to *c*—perhaps 5 feet altogether over the branches—to form a close fence, but also a light top to encourage the upward growth of the plant; while the sloping face on each side affords room for the naturally upright, straight, stiff, spiny shoots to grow upwards.

5636. A seasonal accident, however, may befall a young hedge in winter—it may be smothered with snow; and on the mass of snow subsiding by consolidation, its great weight may strip off many of the lateral branches, and break down the top shoots. This accident I have seen occur, and there is no evading it; for the strongest branches of the largest hedge may be stripped off by the weight of snow. In such a case the young plants must be pruned in spring by the removal of all the injured parts, with a pruning-knife, but no more. No matter though this necessary pruning leave the young hedge in an unequal state—some of the plants being much crushed, whilst others have escaped injury—let it grow; and although the pruned plants may not overtake the others, these latter can be afterwards pruned to a proper size one year earlier than they would have been, had no accident befallen the hedge.

5637. There are commonly two forms of hedges found on farms in Scotland. One is the pointed or hog-mane shape, as shown in fig. 462; the other is the more natural form of the plants, assumed by having leave to shoot up their tops, whilst the lateral branches are switched off. Though these two forms are also found in England, the country of luxuriant hedges, other forms are met with—many picturesque in the extreme, but otherwise not desirable, inasmuch as hedges with large expanded tops occupy much valuable ground. Were such a broad-topped form allowed in some parts of Scotland, the first winter's snow would inevitably crush the hedge down to the ground. Of the two forms referred to, either may be adopted according to circumstances. Along both sides of a turnpike road, the low hog-mane is most advisable, to allow the free action of the wind upon the road. A height of from $4\frac{1}{2}$ feet to 6 feet will suffice for the purpose. The natural method is admir-

ably adapted to afford shelter, and should therefore be reared against the stormy quarter of the farm; and, as pruning is attended with trouble and expense where hedges thrive luxuriantly, they may be allowed to grow up where they cannot do harm, as upon heights and in hollows. After having attained its natural height—which, in the thorn, may be 10 feet—the plants acquire thickness of stem, which, if let alone, will continue to increase for many years. But while it becomes thicker, the plant changes its character, gradually forsaking the form of the hedge-plant, and assuming the more natural form of the tree—enlarging its head by the lateral expansion of the upper branches, and elevating its stem by a natural pruning of the lower ones—every year thus rendering itself more and more unfit for a fence. In observing this natural tendency in hedges, the hedger should consider, that the thorn-plant is not in its natural state when placed in line as a fence along the side of a field; and, consequently, if he desires to retain it as a fence, he must restrain its tendency to become a tree. He has all this in his power, and may even make an old hedge resume its youthful habits by well-timed pruning, for such is the accommodating nature of the thorn-plant.

5638. The only sort of pruning suitable for so strong a hedge is cutting it down; and there are two modes of doing this—one by leaving the stems and some of the branches at a certain height from the ground, the other by cutting off all the branches and the stems to within a few inches of the ground. The former is called *breasting over*, the latter *cutting down*.

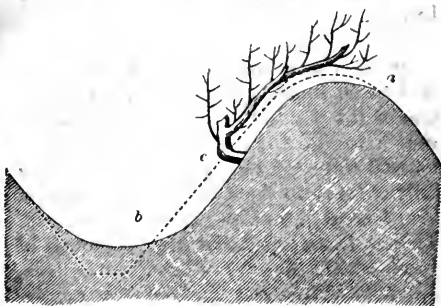
5639. The instrument with which a hedge is *breasted over* is called a *breasting-knife*, and is like a switching-bill, fig. 461; but the blade is somewhat shorter and stronger, and the implement altogether heavier. It is used with a single back-handed upward stroke. It costs from 3s. to 7s. 6d. On stating this difference of price, I may remark that it arises solely from the quality of the article. The common English hedge-bills, *made for sale*, cost only 3s. a-piece; but the probability is, that a good day's work cannot be got

out of 1 in 10 of them; whereas the Scotch-made 7s. 6d. bills will last for years, give satisfaction all the time, and prove themselves the *cheapest* instruments in the end.

5640. On determining the age to breast over a hedge, its stems should not be stronger than a hedger can cut through with one hand by two or three strokes of the breasting-knife. The hedger, on commencing this operation—using the knife in his right hand, and covering his left with a hedger's leather-glove—stands on the hedge-bank, near the hedge, with his face outwards, and his right hand to the hedge to be cut down. After cutting a few thorns in any way at the end of the hedge, to make room for himself to stand upon its bank, he commences cutting the principal stem of the plant nearest him, at about the height of his knee above the ground where it is growing. In cutting, he uses the knife, by first making a firm cut upwards upon the stem, the knife perhaps penetrating to the heart; and if not much exceeding 1 inch in diameter, he may cut it through at one stroke; but the generality of the stems will require more than one stroke, although I have seen a hedger, of by no means great personal strength, cut through thicker stems at a stroke than his appearance would indicate ability to do. But supposing the first stroke to penetrate about an inch, the next one is given in a downward direction to meet the inner end of the first stroke, so that a wedge of the stem may be cut out. The wedge flying off, the next stroke is given in the exact line of the first, and it will most probably sever the stem; but if not, another at the furthest corner of the cut, and one at the nearest, will send the knife through. All the cuts made with a view to remove the wedge-shape pieces are comparatively light; but the upward cuts intended to sever the stem are given with force; and both sorts of strokes follow fast, until the stem is cut through. In renewing each stroke, the hedger's left hand is ready, the moment the knife is brought in front of his body, to receive its back between the fingers and thumb, as a rest and a guide for the next stroke. The cut stem will either drop down on end upon the ground behind the line of the hedge, or will be kept suspended, by the interlacing of its

branches amongst those of the plant beyond it. On the stem being severed, the hedger seizes its lower end with his gloved hand, and, with the assistance of the knife in the other, pulls it asunder from the adjoining plant, and throws it endways either on the headridge beyond the ditch beside him, or upon the head-ridge of the field behind the hedge-bank, whichever place may have been selected for carrying away the thorns from, to be made into a dead-hedge. Standing up at the far side of the sloped cut of the stem, there may be a small splinter of wood and bark, left by the last stroke of the bill; though with a dexterous hand this seldom happens; yet, to give the cut a finished appearance, the hedger cuts off the splinter neatly with his bill, held in both hands. All the lateral branches growing from the stem are cut off in the same manner as far back as the top of the hedge-bank, with an inclination corresponding to the slope of its face, so that the backmost branch preserves about the same height above the top of the hedge-bank as the stem in front does above the hedge-line. The finished breasting may be seen in fig. 463, where the sloping cuts are shown in

Fig. 463.



A BREASTED OVER THORN-HEDGE, WITH THE HEDGE BANK AND FACE WORN DOWN.

the main stem at *c* along the other stems from *c* upwards above the hedge-bank. The hedger proceeds in this manner until the entire hedge is cut down. The cost for breasting over a hedge is about 4d. per rod of 6 yards. If the stems, such as at *c*, are strong and hard, the cutting-bill may be used for the stems, and the breasting-knife for the branches. A pair of hedger's gloves costs 1s. or 1s. 6d.

5641. Breasting is best suited to a com-

paratively young hedge, every branch and stem of which will soon be covered over with young twigs, which will ere long form a close structure of vigorous stems; but an older hedge, one that has reached its utmost natural height of 10 feet, when determined to be cut down should not be breasted over, as is too often done, but *cut down* within a few inches of the ground. This is a very different operation from breasting, inasmuch as it leaves no branches, and only a small portion of the stem.

5642. The instrument used for this purpose is the cutting-bill, fig. 464. It has a blade 7 inches long, and $2\frac{1}{2}$ inches broad; a helve $2\frac{1}{2}$ feet in length; and the bill altogether weighs 6 lb. It is used exactly in the same manner as the breasting-knife; but being so much heavier in itself, and employed on stronger plants, it requires greater labour to wield it. It costs 7s. 6d., the highest price of such instruments.



THE CUTTING-BILL.

5643. In cutting down an old hedge with this bill, the hedger stands upon the side of the ditch under the line of hedge. From this position the strokes are given upwards, but near the ground at first; and, to give freedom to the hedger, he first uses the breasting-knife to clear away all the small branches that grow out of and around the stem to be cut through. Without this precaution, the operating hand of the hedger might be severely lacerated by the straggling branches. The stem being thick, many strokes will be required to cut it through; and many of these will have to be given downwards, to cut away the wood in wedges. The left hand is used to rest and guide the bill, as it did in the case of the breasting-knife. When severed, the stems are laid upon the ground, on either or both sides of the hedge, as the thorns may afterwards be required. The cost of cutting down an old hedge is $2\frac{1}{2}$ d. per rood of 6 yards. It

is cheaper than breasting, though in itself harder labour, because only one stem has to be cut through to remove the entire plant.

5644. A still older hedge, with stronger stems, requires the hedger's light small axe, fig. 465, to cut it down. It

Fig. 465.



THE HEDGER'S AXE.

weighs 3 lb., and its helve measures 3 feet in length. It costs from 1s. 8d. to 2s. 6d., ranging in size from No. 1 to No. 4. In using it, the hedger stands in the opposite direction to using the breasting-knife and cutting-bill; he has the left hand next the hedge, and uses the axe with both hands, and directs its strokes as with the carpenter's common axe. The twigs are first removed by the breasting-knife. The cutting strokes are all made upwards, and the obstructing timber is wedged out in pieces.

5645. In all these cases of cutting over the stems of the thorn-plants, the incision slopes upwards from the face towards the back of the hedge. The cuts on the growing stems are made by the hedger not in the plane of the line of the hedge, but at a considerable angle to it; so that, when the cuts are viewed in the direction in which the hedger proceeds in cutting, they are not visible, while from the opposite direction they almost face the spectator.

5646. Hedges are wofully mismanaged in the cutting in many parts of the country. Without further consideration than saving the expense of a paling to guard a new-cut-down hedge, or in ignorance of the method of making a dead-hedge from the remains of an old live one, the stems of an *old* hedge are often cut over about $3\frac{1}{2}$ feet high, to remain as the fence. The consequence is just what might have been anticipated from the known habits of the thorn—a thick growth of young twigs where the hedge was cut over; and the ultimate effect is, that of a young hedge standing at $3\frac{1}{2}$ feet above the ground upon

bare stakes. The only plan, therefore, to make an old hedge a valuable fence, is to cut it over near the ground, and form a dead-hedge with the part cut off to protect it.

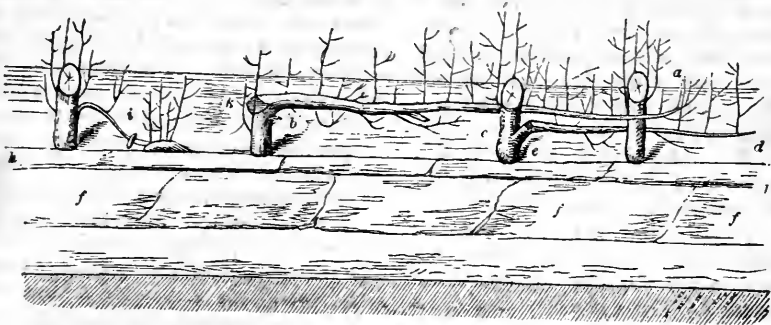
5647. But another mismanagement is in the mode of making the cuts when hedges are cut down. The bill is too often used to *hack down* the stems, instead of to *cut off the branches*; and the consequence to the stems is the opposite of what is right—the branches, worthless when severed from the hedge, being cut off clean; while the top of the stems, upon which depend the future fence, are shattered to pieces. This barbarous work is occasioned by giving a downward instead of an upward stroke in cutting off the branches from the stems. Fortunately for the owner of the hedge, the natural habit of the plant in part counteracts the mischievous work of his own hedger; for, hacked and split as the stems are, they nevertheless push out young twigs, and conceal, though not cure, the injury they have received. The difference in the effects of the strokes in cutting a hedge well and ill, is thus truly explained by Mr Francis Blaikie: "A moment's reflection," he says, "will show that it is impossible for an edge-tool to pass through a piece of timber without causing a severe pressure against one or both sides of the wood, because the tool occupies *space*. The teeth of a saw drags the chips out of the cut, and *give the space* requisite for the tool to pass, but an edge-tool can only pass by pressure. . . . In cutting the stem of a hedge or young tree which is growing upright, if the blow is struck *down*, nearly the whole pressure falls on the stub or *growing stem*, which is *shattered to pieces*, while the stem cut off is *left sound*; but when the blow is struck *up*, as it should always be, the effect is reversed, the *stub* is then *left sound* and smooth, is cut *clean*, and the *stem* cut off is *shattered*." The advantage of the proper method is, that "when this latter practice is adopted, the wet does not penetrate through the stub into the crown of the roots, canker is not encouraged, and the young shoots grow up strong and healthy, and able to contend against the vicissitudes of the weather."*

5648. Hitherto the pruning and cutting have proceeded on the supposition that the hedge cut down would make a sufficient fence when it grew up again; but this will not be the case if many of the stems are as far asunder as to leave gaps between them, even after the young twigs shall have grown up. In such a state the pruned hedge will never constitute an efficient fence without further assistance; and the mode in which that is rendered is termed *plashing*, which consists of laying down a strong and healthy stem from the one or the other side across the gap. On cutting down the hedge, where the hedger meets with a gap which cannot be filled up by the ordinary growth of the young stems, he leaves a healthy supple plant standing beside it, on the side of the gap next him, that, when plashed, they may all lie in the same direction. After the hedge is cut down, the hedger plashes the stems he left standing in the following manner:—Commencing at the end of the hedge where he began to cut, he first prunes off, with the breasting-knife, all the branches from the stem, cuts the stem of the proper length for the gap, and then makes an upward cut in it near the ground, on the opposite side to the direction towards which the stem is to be plashed, but no deeper than is necessary to bend it to the proper position, which should be as near and parallel to the ground as possible; for, unless the stems are laid as close to the ground as to fill up the gap from the bottom, there is no use of plashing. The plashed stem is partly kept down either by a snag on the stem on the other side of the gap, or by wattling it before and behind two or three stems, or by a hooked stick driven into the ground near its point, and partly by a wooden wedge, severed in cutting the hedge, inserted into the cut, which is defended from rain and air by a lump of clay. Plashing is represented in fig. 466, where *ed* is the first plashed stem, cut nearly through at *e*, and laid along near the ground, across the gap which extends beyond *d*; *ba* is a stem passing across the large gap *bc*; *k* is the wedge of wood inserted into the cut of the plashed stem *ba* to keep it down. The stem *ba* extends beyond the immediate gap from *b* to *c*,

* Blaikie *On Hedges*, p. 33.

since there is no means of fastening it down at *c*, and its end is wattled in front of the stem *a*; but had there been a means of fastening it at *c*, it should have been

Fig. 466.



THE PLASHING, AND LAYING OF AN OLD HEDGE, AND THE WATER-TABLING OF A DITCH.

cut off there. It will also be observed, that the stem *e d* originates at *e* and not at *d*, though the gap is really beyond *d*, and not between the stems *c* and *a*, because no offshoot was found on *a* to leave for a plash; and had there been, the stem *e d* would have been cut off altogether, and the plash laid across the gap *a d* from the off-shoot of *a*.

5649. Plashing hedges is much practised in England, where it is frequently very neatly executed; but I cannot help thinking that many a good hedge is there needlessly cut down for the sake of being plashed. Plashes are there laid at all possible angles, and twisted into all possible forms, as if to prove that the thorn plant can withstand every possible torture. I cordially agree with the following sentiments on the practice of plashing, and they also tell us the history of the origin of most of the gaps to be seen in hedges. "Plashing an old hedge," says Lord Kames, "an ordinary practice in England, makes, indeed, a good interim fence, but at the long run is destructive to the plants; and, accordingly, there is scarcely to be met with a complete good hedge where plashing has been long practised. A cat is said among the vulgar to have nine lives. Is it their opinion that a thorn, like a cat, may be cut and slashed at without suffering by it? A thorn is a tree of long life. If, instead of being massacred by plashing, it were raised and dressed in the way here described, it would

continue a fine hedge perhaps for 500 years."*

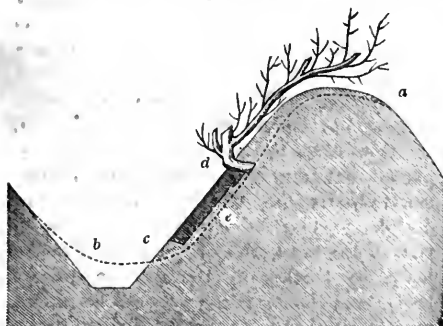
5650. Immediately connected with the pruning of hedges in spring is the *scouring of the ditches*, which serve to keep them dry, and the *repairing of the hedge-banks*. A ditch which conveys a pretty constant stream of water may have as much mud deposited in it as to require scouring before the space about the roots of the hedge is able to accommodate all the matter that should be scoured out of it. In this case, as much mud should be placed between the hedge-roots as can conveniently lie, which will serve the double purpose of easily getting rid of part of the mud, and of doing good to the hedge by thickening the soil around its roots; and the remainder should be placed on the ditch lip on the headridge, to be removed at leisure for other purposes.

5651. But the more usual practice is, that, when the ditch is to be scoured out in a thorough manner, the hedge is at the same time pruned, and the hedge-bank repaired. The propriety of combining these works will be rendered obvious from the following considerations: After the process of weeding hedges has been conducted for some years by removing the grass from the side of the ditch, and the weeds as they spring up on the face of the hedge-bank, the earth will be found removed much below its original place in all soils. The incessant action of the

* Kames' *Gentleman Farmer*, p. 283.

atmosphere, and of rain and snow occasionally, upon the inclined surface of the hedge-bank, sensibly co-operate with the weeding to remove the soil from the roots of a hedge. The combined effects of these causes are, that in time the roots are left too bare; and if the deficiency is not remedied, it will cause the whole hedge to be shaken to the roots by every wind that blows. By looking back to fig. 463, it will be seen that the soil has been removed from the hedge-bank, and the bottom of the ditch filled up to the extent indicated below the dotted line *b c a*, from the centre of which space the root of the hedge projects at *c*. The deficiency of the soil can be easily supplied, and it is done by *water-tabling*. Water-tabling can only be executed in the *best* manner after the hedge has been thoroughly pruned. It is begun by making a sharp notch with the spade, 3 inches deep, in the side of the ditch, about a foot below the root of the thorns, at *c*, fig. 467. The hedger then pares

Fig. 467.



THE MODE OF WATER-TABLING A HEDGE-DITCH.

away all the earth to that depth from below the thorn-roots to the notch, preserving the proper inclination of the side of the ditch. If the side of the ditch is found worn away to a greater depth than the required paring, earth should be rather put on than taken away from below the root of the hedge, as seen between *e*, the dotted line, and the sods *c* and *d*. In the meantime the hedger's assistant—for water-tabling is most expeditiously and better done by two men than one, in proportion to the number, though the hedger might do all the work himself—the assistant raises sods from the best part of the bottom of the ditch, 9 inches broad, 4 inches thick, and of the depth of the spade in

length, and lays them aside for the hedger. The hedger then places these sods with the spade upon their edge on the notch, with the grass side outwards, and beats them to the bank, making them all of the same width by paring their upper edge, and keeping them in a straight line. The sods unite to each other the more quickly and firmly when their ends are cut acute-angled, instead of square—not only in their thickness, but in their breadth—as is partially shown at *fff*, fig. 466, which represent the faces of the sod *c*, fig. 467, when set. The reason for putting the grass side of the sods outwards is, that the sods may adhere and grow to the bank; for if they were put on with the grass side inwards, the frost of the ensuing winter would cause them to slide down; and there need be no apprehension of injury to the hedge from the growth of the grass from the sod when it is set at some distance below the hedge-roots. This is called the *set-sod*. While the hedger is engaged in setting these sods, the assistant raises others 6 inches broad, 4 inches in depth, and of the length of the spade's face. After a few of these smaller sods have been made ready, the hedger lays them, so as to break joint with the set-sods, with the grass side downwards, upon the upper edge of the set-sods; beating them flush with the face of these, and pushing them under the thorn-roots. This sod is called the *table*, and is seen in section at *d*, fig. 467, and in face from *h* to *g*, fig. 466. The reason for placing the grass side of the table downwards is to prevent the grass growing immediately among the roots of the thorns, whence it could not be removed without frustrating the very purpose for which the water-tabling was performed, by taking away the earth from the thorn-roots. On the hedger proceeding with the tabling, the assistant throws the parings of the sides and the scouring of the bottom of the ditch upon the hedge-bank, behind the table-sod, and amongst the thorn-roots, to fill up every vacant space he observes. This filling up is seen from *d* to *a*, fig. 467; and in fig. 466, from *d*, *e*, *c*, *b*, *k*, to *i*. Water-tabling itself costs 2*l.* per rood of 6 yards, and the scouring of the ditch additional, according to the state it is in at the time, and the difficulty of doing it. Cutting, water-tabling, scouring, and repairing hedge-bank, may

be done from 8d. to 1s. per rood of 6 yards, according to the tenacity of the soil.

5652. Water-tabling renovates the growth of thorns, re-establishes their hold of the bank, as no wind can shake them to their roots, and encourages the springing of shoots around the incised parts of the stems and branches. It is not needed where a hedge has been planted on a scarcement, because the mouldering of the earth from the plants is prevented by it; but the advantage is more than counterbalanced by the encouragement the scarcement affords to the growth of weeds. (5626.)

5653. It is possible that in the oldest hedges, when cut down, there may be gaps of such width as cannot be repaired by plashing, so that other expedients must be adopted to fill them up, and two present themselves to notice; one by laying young shoots from the old stems into the gaps, and the other by filling up the gaps with young thorn-plants. The laying cannot be done in the same season with the cutting down of the hedge, nor until the young shoots are pretty long; but young quicks may be planted immediately after the water-tabling has been finished.

5654. Where young quicks are to be planted amongst old thorn roots, the scouring from the ditch should not be put on those places, but rather the old soil removed from them, and spread behind and between the old roots where are no gaps. New and fresh soil should be prepared for the purpose, by mixing mould, decayed vegetables, and lime together in a compost; and, when ready for use, put into the places formerly occupied by the old soil. The young thorn plants are prepared as in fig. 457; and on a trench being formed for them in the new compost earth, in the line of the old hedge, they are laid upon rotted farmyard dung, and the earth brought over the dung and plants, and beaten down; and should the weather prove dry, or likely to become so, they should be well watered. The young plants will grow rapidly; and to preserve them from all annoyance, prune away any straggling twigs from the old stems.

5655. The *laying* of young twigs is managed much in the same way. The old soil is removed from the gaps, and is replaced by the compost. A stout twig is brought down from the stem on each side of the gap, cut short and notched, and held down amongst well-rotted dung by a hooked stick, and covered with the compost earth. This process is attempted to be represented in fig. 466, where *i* is the laid twig from the old stem *h*, held down by a hooked stick. After the layer has completely taken root, and the young shoot is growing with vigour, its connection with the old stem should be severed. It is obvious that this plan will fill up a gap no larger than can be occupied by one shoot from each side of it.

5656. I observe farmers removing the ordinary hedge-bank behind a thorn-hedge to make compost of; but the practice is highly injurious to the hedge, even after it has grown up, by exposing its roots, which grow chiefly in the bank, to wet and frost. If a hedge is cut down whose bank has been treated in this manner, and the roots left unprotected by the removal of the branches above them, it is possible that a few nights of severe black frost will kill every root nearest the surface. I have no doubt that particular plants of old hedges are killed in this manner, without the cause being suspected by the farmer. When the hedge-bank has been thus removed, and the hedge cut down, provision should be immediately made to protect the roots, which may be done by covering them with the scouring of the ditch. If the ditch, scoured to its usual size, cannot afford sufficient materials to answer the purpose, it should be made larger. A low turf-wall as a backing, obtained at hand or brought from a distance, makes a neat hedge-bank, and saves a good deal of soil. Even a double hedge-bank, or a large single one, should be removed with caution, as many of the best roots will have reached through its extreme breadth.

5657. The *buds* of the young hedge that was planted in the early part of winter will show symptoms of life early in spring, by exhibiting curious blisters of mould upon the face of the bank. The

blisters at length fall off, and expose the bud. In most cases, assistance should be afforded the young buds to break their prison bonds, by removing the blisters with the finger or a small piece of stick, after which they will soon burst into leaf.

5658. When it is determined to cut down or breast over any hedge, the operation should not be done at random in any season or year. It should not be done in the depth of winter, nor when the field is in grass or is coming into grass, but only when going out of grass; for, hedges being specially intended for fences against stock, it would be absurd to remove them when they would be of use in that respect. Still it will scarcely be possible to avoid giving inconvenience to one field or another, as it rarely happens that two adjoining fields are under the same member of the rotation; and in the case of old grass fields, it is not possible to avoid it; so that the most that can be studied is to avoid cutting down the hedge as long as the field in which it grows continues in grass, whatever may be the state of the field adjoining. The compromise between two grass fields is this,—that, when the hedge of the one going out of grass is cut down, thorns are furnished for a dead-hedge to fence the other that is still to be in grass.

5659. Let us now proceed to construct a *dead-hedge*. A hedger and an assistant are necessary to construct it, which is done in this manner:—The assistant, protected by gloves, cuts the severed stems of thorns into pieces of about 3 feet in length with the cutting-bill or axe, figs. 464 and 465, according to the strength of the stems, which, when very thick, had better not be employed for this purpose, the branches they afford being better adapted. He lays one cut piece above another, until a bundle is formed that he can easily lift from the ground, taking care to add small twigs to it to thicken its substance, to compress it with his foot, which should be shod with a hedger's clog, to make the pieces composing the bundle to adhere to each other, and to trim it, by notching the longer twigs in with the bill to improve the appearance of the bundle. He thus makes one bundle after another.

5660. The hedger meanwhile takes his station on the line chosen for the dead-hedge to occupy, which is either immediately behind the hedge-bank or one foot from the lip of the ditch in front of the hedge, according to the side on which it is intended to fence the hedge just cut down. If placed behind the hedge, the dead-hedge should not be set upon the top of the hedge-bank, as cattle and horses would then easily reach over it, and crop the young shoots as they grew up, but should occupy its foot.

5661. A dead-hedge should be constructed so as not to be affected by the prevailing winds of the locality, otherwise, it may be torn and even upset by a high wind, for which reason its head should slope in the direction the dreaded wind blows.

5662. The first thing the hedger does is to lay a spadeful of earth against the fence from which the dead-hedge is to run, and the trench thus made in the ground should be as large as easily to contain the lower end of a bundle of thorns, as *a*, fig. 468. The first mound thus

Fig. 468.



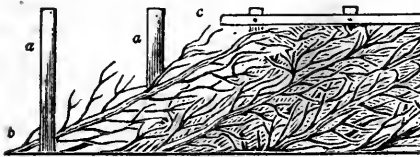
THE DEAD-HEDGE OF THORNS.

laid up forms a lean for the first bundle. When the hedger is ready with the trench, his assistant bands him a bundle with a fork, which should be long-shafted, to enable him to reach over the top of the breasted hedge, when the thorns have been laid in front of the hedge; but if they have been laid upon the head-ridge behind the hedge, which they should always be, when to be used there for a dead-hedge, a short-shafted fork is the most convenient. The hedger receives the bundle with his gloved hands, and places its but-end into the trench, pushing it

with his clogged foot, and making its head slope from him. A tramp of earth is then raised with the spade, and placed against the but-end of the bundle to hold it firm. Thus bundle after bundle is set up firmly by the hedger; and after a few yards have been thus set up, he cuts in all straggling sprays with the breasting-knife, and chops the top and outside of the bundles into a neat form of dead-hedge, having perpendicular sides and a flattish head. All the thorns of a strong hedge will not be consumed by a dead-hedge of the same length. A dead-hedge will last as long as until the pruned hedge again becomes a fence, after which it may be used as fuel. The figure does not represent the dead-hedge in so massive a form as it really has, but by giving the ground in section it distinctly shows the position of one bundle with another.

5663. Another form of dead-hedge is the *stake-and-rice*, and it is formed of the branches of forest trees; and where these are plentiful and thorns scarce, it is an economical dead fence. Its structure is shown in fig. 469, where *a a* are stakes

Fig. 469.



THE STAKE-AND-RICE DEAD-FENCE.

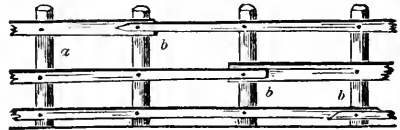
fashioned from the longer branches of the tops of trees; or, should the tops be too small to afford sufficiently strong stakes, these should be procured from sawn timber, $4\frac{1}{2}$ feet in length, and about 4 inches in the side, and after being pointed, driven in line into the ground from 4 to 6 feet asunder, according to the length and strength of the tops. The same principle which determines the inclination of the bundles of a dead-hedge, in the direction of the heaviest winds, is followed in setting the tree-tops in stake-and-rice. They are set in that direction on their but-ends upon the ground *b*, at an inclination of about 45° , and each one is wound alternately before and behind the stakes as far as it reaches. A neat and stout finish is given to stake-and-rice, by nailing a single rail of paling along the top of the stakes, as

at *c*. Any sort of brushwood, provided it reaches from one stake to every alternate one, will answer for stake-and-rice; and, if the brushwood be naturally short, the stakes can be set the closer together.

5664. Such a species of fence requires fewer nails, and less good wood, than an ordinary paling, and is therefore cheaper; and it will stand an equal length of time, as the stakes have less strain upon them, not having the same weight of materials to bear. The branches being warped before and behind, protect the stakes from many accidents to which those of paling are liable; such as persons climbing over them, swing-trees catching them, cattle and sheep rubbing against them. Stake-and-rice forms a much better fence and shelter for sheep than a paling, on which account it should be placed on the N. and W. sides of fields, whence the strongest and coldest winds prevail. Its close structure renders it at times liable to lodge snow, that would find its way through the rails of a paling, by the weight of which it is apt to be crushed down, but not more so than a dead-hedge of thorns.

5665. A very common dead-fence for protecting hedges and grass from stock in spring and summer, is the common wooden paling, fig. 470. If tall grown Scots

Fig. 470.



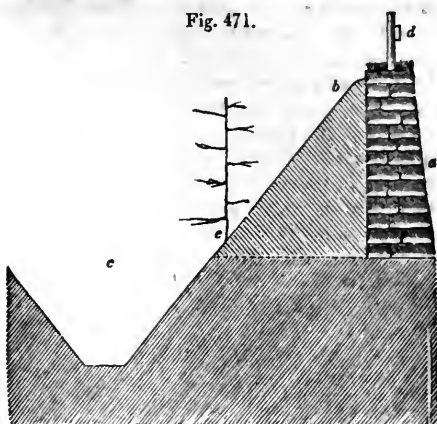
THE COMMON WOODEN PALING.

fir, 8 inches in diameter, can be procured at no great distance, or is grown upon the property of which the hedges are to form a fence, more handy materials for temporary fencing of young thorn hedges need not be desired. Trees of that size will cut up into deals, which, besides the outside slabs, will divide up the middle for rails of $3\frac{1}{2}$ inches broad and perhaps 24 feet in length. The same trees, quartered, will make stakes which, if cut off at $4\frac{1}{2}$ feet in length, and pointed, are fit for use. Weedings of plantations, either of Scots fir or larch, are also very convenient for cutting up into paling, either entire or sawn up the middle. A paling should

be on the same site as a dead-hedge, behind the hedge-bank or on the ditch lip, (5660.) Stakes, as *a*, should be driven by a mallet, fig. 41, 12 inches into the ground at 5 or 6 feet asunder, and where hard, a hole may be made by the foot-pick, 247, or the driver, fig. 42; and such stakes will support a paling of 3 feet 3 inches in height. Two rails are sufficient to fence cattle, but three are required for sheep. To give additional strength to the fence, the rails should be nailed on the face of the stakes next the field, and made to break-joint, so that the ends of all the three rails shall not be nailed upon the same stake; nor should the broad ends of the rails be nailed together, even though thinned by the adze, but broad and narrow ends together as at *bbb*, that the weight and strength of the rails may be equalised. To make the paling secure, a stake should be driven as a stay in a sloping direction behind the rails, and nailed to every third stake. The upper rail should be nailed near the top of the stakes, the lowest edge of the lowest one 6 inches from the ground, and the upper edge of the middle one 20 inches above the ground. The best nails for paling are what are called "Scotch made stout paling nails," from 3 to 3½ inches long. Such a paling, where wood is not scarce, costs 1s. 2d. per rood of 6 yards. A stout one with three rails, where wood is not plentiful, 2s. per rood. In the Stewartry of Kirkeudbright wood is so cheap that a paling of 4 rails, with stakes at every 4 feet, can be put up for 9d. or 10d. the rood. Charring the points of the stakes, for paling or stake-and-rice, no doubt incurs some additional expense, but it renders them much more durable. Painting them with coal tar, and letting it dry, as far as they are driven into the ground, is perhaps as good a means of preservation.

5666. When turf is plentiful, it may be employed to fence one side of a young hedge. Let *a*, fig. 471, be a turf wall 4 feet high, 18 inches broad at the base, and 12 inches at the top, coped with large turf; and *b* the soil thrown out of the ditch *c*, inclined upwards towards the top of the turf wall. For confining Cheviot and Black-faced sheep, and cattle, a short stake and

single rail of paling will be required along



TURF FENCE TO A THORN HEDGE.

the top of the wall; but Leicester sheep will be confined without a rail.

5667. Lord Kames says, and there are farmers who seem to adopt the opinion, that "the hedge is fenced from cattle on the one side by the ditch; but it is necessary that it be fenced on both sides. The ordinary method of a paling is no sufficient fence against cattle; the most gentle make it a rubbing-post, [not if there be a rubbing-post, which there should always be,] and the vicious break it down wantonly with their horns. The only effectual remedy is expensive; but better no fence than one that is imperfect. The remedy is two ditches and two hedges, with a high mound of earth between them."* We are left to infer from this that a paling is not sufficient protection to a hedge, but that two ditches and a mound are. A fence on both sides of a young hedge, or one new pruned, is absolutely necessary; and the sort of material it should be constructed of depends on the facility or difficulty of obtaining it; but whatever may be the material, a fence made of it is a much better protection to a young hedge than any number of dry ditches.

5668. *Summer*.—The attention which hedges require in summer is confined to weeding; but the operation is a very important one, not only as regards the hedges themselves, but also the condition

* Kames' *Gentleman Farmer*, p. 278.

of the fields near them. I am ashamed to say that this department of farm-work is much neglected. The hedger himself can do little to the weeding of an extensive range of fences; and he is, besides, called away, in summer, to many other sorts of work which have no relation to his own occupation. The field-workers, who assist him in weeding, are engaged at field labour; and it is only at intervals that they can be spared from their necessary avocations. I have found it a good plan to employ old men, who are unable to undertake ordinary labour at ordinary wages, in weeding hedges by the piece; and if they are diligent, it is surprising the extent of fence they will keep clean during a summer. Old women might be employed at the same occupation; and an aged couple might employ a part of their time every day at this sort of work, with advantage to the farm and their own pecuniary means.

5669. The implements are but few that are required for the weeding of hedges. They consist of a hedge spade, fig. 472,



having a thin cutting face, of a rectangular form, attached to an iron shank terminating in a socket, into which is inserted a helve, 2 feet long, with a cross head. This spade is held horizontally in both hands, and is used to cut away the grassy face of the ditch below the line of hedge; and to prevent the hands coming in contact with the bank, the shank is slightly bent into a form to preserve a parallelism between the line of the spade and that of the helve. The hedger alone uses this implement. It costs 4s. or 5s. Another implement is the common Dutch hoe, fig. 473, with a helve 5 feet long, with a cross head. Its use is to remove the weeds from the top and face of the



THE DUTCH HOE. fig. 473, with a helve 5 feet long, with a cross head. Its use is to remove the weeds from the top and face of the

hedge-bank; and in order that it may get between the hedge-roots its face should be narrow. It costs 3d. per inch along the face. A small useful implement is the

Fig. 474.



THE HEDGE WEED-HOOK. the hedge-roots, into the ditch, that have come down by the Dutch hoe from the hedge-bank.

5670. The manner of using these implements is this:—The hedger steps into the bottom of the hedge-ditch with his face towards the hedge, and having in his right hand the cross-head of the hedge-spade, and resting its helve in his left above the socket, he works the spade in a horizontal position, removing all the grassy and other plants growing on the face of the hedge-bank below the line of thorns along the entire side of the ditch, and pushing them into the bottom. If the thorn-bed was formed of turf, the grass below the line of a young hedge may be expected to be pretty strong; but if made on fallowed ground, the weeds, if not few, will not be strong. Whatever may be the state of the weeds, they should be removed from the young hedge, in time to prevent them scattering their seed; for which end the weeding should be undertaken as early in the summer as possible, not merely before the weeds come into seed, but before they arrive at the blooming period. While the hedger takes the lead of weeding the *face* of the hedge-ditch below the hedge, a field-worker follows him on the hedge-bank, and removes the weeds with the Dutch hoe along its *top and face*, stirring the whole surface, but not deeper than is necessary to remove the weeds. Such of the weeds as fall on the top of the hedge-bank get leave to lie and rot there; whilst those on its face, immediately behind the hedge, are drawn through between the hedge-stems into the ditch, with the crooked stick, by each of the field-workers who follow the hedger in the ditch, and the field-worker on the top of the hedge-bank. The field-workers take their turn at the Dutch hoe,

as it is severer work than using the crooked stick, which merely saves the hands and fingers of the workers being scratched by the thorns in reaching the weeds between the stems. I could never ascertain the cost of weeding a young hedge in that way, as it depends on the quantity and state of the weeds; but I remember an old man taking on the job one summer at 1d. per rood of 6 yards. He first used the Dutch hoe along the bank for one yoking, then the hedge-spade for another, and completed the clearing the space previously gone over of weeds with the crooked stick. Were the hedges constantly weeded every summer, the cost would be very much below this sum. When the hedge has attained 3 or 4 years old, it so overshadows the face of the hedge-bank behind it, that few if any weeds get leave to appear; so that the hedge-spade in front, with only a skimming of the Dutch hoe on the top of the hedge-bank, is all the work required. When the hedge has grown to cover the hedge-bank entirely, the Dutch hoe is dispensed with, and only the hedge-spade is used. The same old man undertook this latter work at $\frac{1}{2}$ d. per rood of 6 yards, so that the spade-work is about half the amount of the whole—which, I dare say, may be near the cost in hedges not allowed to be overrun with weeds; and where hedges were originally planted in fallow ground instead of on lea, and where they are weeded constantly every summer, the weeding would cost a great deal less than this sum.

5671. The weeds which infest hedges are numerous, many of which are common to them and corn and pasture; but others are chiefly found in hedges, such as the sticking-grass, *Galium aparine*; great bindweed, *Convolvulus sepium*, a creeper abundant in England; Bishops' or gout weed, *Ægopodium podagraria*, which resists eradication; ground-ivy, *Glechoma hederacea*, a creeper; hog-weed, *Heracleum spondylium*, a coarse rank plant, growing from 4 to 5 feet in height; meadow vetchling, *Lathyrus pratensis*, a strong creeper with yellow flowers; common hedge-mustard, *Sisymbrium officinale*, flowers very small, pale yellow; woody nightshade, *Solanum dulcamara*, in moist situations; hedge-woundwort, *Stachys silvatica*, flowers purple, whorls of about 6 flowers; upright hedge-parsley,

Torilis anthriscus, fruit densely clothed with incurved bristles; zig-zag trefoil, *Trifolium medium*; tufted vetch, *Vicia cracca*, with fine bluish-purple flowers; and hedge-vetch, *Vicia sepium*, with large leaflets.

5672. Numerously as these crowd together to take shelter in hedges, there are other intruders which insert themselves between the thorn-plants, and, acquiring strength from the protection afforded them, at length overcome their protectors. Of these, the most destructive to hedge-plants are the crab-apple, *Pyrus malus*, which easily makes room for itself with its stiff elbowing branches; the sloe, *Prunus spinosa*; common dog-rose, *Rosa canina*, and even the favourite sweet-briar, *Rosa rubiginosa*, placed as it is in a hedge for the sake of its odour—both these never fail to injure thorn-plants, as far as their spreading arms can reach; the broom, *Cytisus scoparius*, and whin, *Ulex Europæa*—both displace the thorn, and, on themselves dying out by old age or severe frost, leave unsecurly gaps; the common bramble or blackberry, *Rubus fruticosus*, and the hazel-leaved bramble, *Rubus corylifolius*, being powerful climbers, completely overrun thorns in many parts of England. The common barberry, *Berberis vulgaris*, is a well-known intruder into the hedges of England.

5673. Weeds growing in the bottom and on the sides of ditches cause the water to fill up the bottom with sediment, and to break down the sides. Among these the beautiful yellow corn-flag, *Iris pseud-acoris*, takes up its station on the sides of ditches, and directs the water to the opposite side; the water-cress, *Nasturtium officinale*, grows in the bottom of ditches, and arrests mud in its progress down them, but will only grow where spring-water flows; the common butter-bur, *Petasites vulgaris*, with large expanded leaves, occupies a prominent position on the ditch side. Dr Hooker relates, that "the early flowering of the plant induces the Swedish farmers to plant it near their bee-hives." The red canary-grass, *Phalaris arundinacea*, with its creeping roots, tufting here and there, proves troublesome in unduly hardening the parts of the sides of ditches where it grows; the reed meadow

grass, *Poa aquatica*, acts a similar part to the canary-grass; the floating meadow-grass, *P. fluitans*, floats its long narrow leaves down the stream of water in the ditch, retarding and stagnating it; the curl-leaved dock, *Rumex crispus*, strikes its roots down the side of the ditch; while the brooklime, *Veronica beccabunga*, is found in the direct water-course. The only mode of destroying weeds in ditches is scouring the bottom, and paring the edges with the common spade, and extracting the roots of the obnoxious plants growing in both.

5674. Mr Curtis gives a hint about destroying some species of weeds in hedges, which seems to derive its importance as a means of depriving the turnip-fly of a harbour in the early part of the season, before the sowing of the turnip crop. "Some benefit," he observes, "might be derived from destroying these cruciferous plants, *Erysimum allearia* and *Condamine pratensis*, to which the *Altica* (2390) are so strongly attached, for they grow in abundance in every hedge and meadow. They appear long before the turnips come up, and attract and give support to the parents of the future swarms that are to sweep away the crops of the farmer. As these plants often flower at the beginning of April, and produce their leaves at a much earlier period, it is almost certain that they nurse the fly, and are its great resources for food and nourishment in the earliest days of spring. The hedge-mustard, and other cruciferous plants on banks and road-sides, are quite under our control; and it is a duty which we owe to our neighbour, as well as to ourselves, to keep our fields and hedges clear of charlock and every other weed of that family, all of which harbour the turnip-fly.*"

5675. The plant commonly used in the hedges of this country is the common hawthorn, *Crataegus oxyacantha*, or sharp-thorned *crataegus*. The generic name is derived from the Greek *κρατος*, meaning strength, in reference to the hardness and strength of the wood. It is the *aubépine* or *aubépin*, whitethorn, of the French; the *hagedorn*, or hedgethorn, of the Germans.

5676. It belongs to the natural order *Pomaceæ* of Jussieu; to *Rosaceæ*, tribe *Romaceæ*, of De Candolle; to *Icosandria*, *Di-Pentajinia* of Linnæus; and to the natural system *Perigynous*

Eogens; alliance *Rosales*; order *Pomaceæ*; genus *Crataegus*, of Lindley.

5677. The common hawthorn is a very variable plant. Mr Loudon enumerates not fewer than 30 varieties. Of these, 7 differ from the species in the general form and mode of growth; 2 in the colour of the flowers; 4 in the development in structure of the flowers; 3 in the time of flowering; 5 in the colour of the fruit; 1 in having the fruit woolly; 5 in the form of the leaves; and 3 in the colour of the leaves.

5678. Of these varieties, the one I would prefer for field-fencing is, I believe, *digynous*. The colour of the young wood is dark purple; that of the new shoots also dark purple, spotted with minute white specks; and that of the old wood, dark orange-purple. Bark smooth and shining; leaves dark-green and shining on the upper face; spines dark purple, of medium length, fine, and sharp; the stems close together in parallel rods, stiff, and upright. Flowers rather large, and haws, dark-red; neither plentiful. The plant is hardy, and will grow in any sort of soil, from clay to gravel that is not injured by stagnant water. Near stagnant water it becomes covered with lichens and moss; will not thrive under the drip of trees, or in company with other plants. The height varies from 15 to 45 feet.

5679. The hawthorn is a long-lived shrub, and, in some situations, attains to a considerable sized tree. Thus, at Duddingston, in the neighbourhood of Edinburgh, is one which, in 1836, was 43 feet high, the diameter of its branches 44 feet; at a little above the roots 10½ feet in girth, and at 3 feet from the ground, 9½ feet. In Forfarshire, at Kinnaird Castle, after being 120 years planted, is one 45 feet high, 40 feet in diameter over the branches, and 35 inches across the trunk. It is growing on a sandy loam or clay.

5680. On account of the beauty and fragrance of its flowers, the hawthorn has been a favoured plant among all nations. "It is said," remarks Mr Phillips, "that the hawthorn flowers not only regale the spirits by their odour, but that they have the power also of counteracting poison. It has been made the happy emblem of *Hope*, because the young and beautiful Athenian girls, brought branches of hawthorn flowers to decorate their companions and friends on their wedding-day, whilst they carried large boughs of it to the altar. The altar of Hymen was lighted with torches made of the wood of this tree, and it formed also the flambeaux which lighted the nuptial chamber. The Romans had also bedecked themselves with branches of hawthorn when they seized the Sabine women. . . . On the first of May, our ancestors never failed decorating with it the Maypole, which was permanently fixed in or near every town and village in the kingdom; and the boldest youth climbed to fix the garland of flowers on the top; whilst others, less courageous, hung festoons and wreaths of flowers

* *Journal of the Agricultural Society of England*, vol. ii. p. 206.

through the garland, and twined them round the pole. . . . This rustic amusement was evidently introduced by the Romans, as we see in it the remains of their ancient games, Floralia, that were instituted in Rome as early as the time of Romulus, and which the Phœceans and Sabines observed in even earlier days.* The hawthorn is the badge of the clan Ogilvy.

5681. The tradition regarding the famous hawthorn at Glastonbury (*C. precox*, a variety of the oxycantha) is thus recorded: "To the S.W. of the town is Weary-all-hill, an eminence," says Mr Nightingale, "which, as the monkish writers inform us, derived its name from St Joseph (of Arimathea) and his companions resting here when much fatigued in travelling through the country, during their pious mission in England for the purpose of preaching the Christian faith. Here it is recorded that St Joseph fixed his staff in the earth, which immediately took root, and ever after put forth its leaves on Christmas day. It had, we are informed, two distinct trunks till the reign of Queen Elizabeth, when one of them was destroyed by a Puritan. The other met the same fate during the Great Rebellion. The blossoms of this tree were esteemed such great curiosities as to become an object of gain to the merchants of Bristol, who not only disposed of them to the inhabitants of their own city, but exported them to different parts of Europe. The probable truth with regard to this tree is, that it was brought from Palestine by some of the pilgrims, there being a species of thorn which blooms at Christmas, a native of that country."†

5682. The haw of the hawthorn is very apt to heat when put in heaps. It is frequently, notwithstanding, sent in large sugar hog-heads, and so great a proportion becomes heated, that not above 1 in 20 germinates when sown. It ought to be packed in not larger quantities than bush-hampers. When sown, it does not germinate until the second spring, and, on that account, nurserymen are in the habit of decomposing the pulp of the haw by mixing them with sandy earth, in flat heaps not exceeding 10 inches in depth, and which are frequently turned, to prevent the haws heating. Game, and many kinds of birds, particularly the thrush tribe, are very fond of the haw; and, on that account, the hawthorn forms an excellent low stunted underwood for the protection of game. It, with holly, *Ilex aquifolium*, and the dog-rose, *Rosa canina*, forms an almost impenetrable barrier against the poacher. Peasants, in many countries, eat the haws; and in Kamschatka they are fermented into wine.

5683. "The wood of the hawthorn is very hard and difficult to work. Its colour is white, but with a yellowish tinge; its grain is fine, and it takes a beautiful polish; but it is not much used

in the arts, because it is seldom found of sufficient size, and is, besides, apt to warp. It weighs, when green, 68 lb. 12 oz.; and, when dry, 57 lb. 5 oz. per cubic foot. It contracts, by drying, $\frac{1}{4}$ of its bulk. It is employed for the handles of hammers, the teeth of mill-wheels, for flails and mallets, and, when heated at the fire, for canes and walking-sticks. The branches are used in England for the heating of ovens—a purpose for which they are very proper, as they give out much heat, and possess the property of burning as readily when green as in their dry state."‡ "The hawthorn is manufactured into clubs for golf-playing."§ Combs were formerly made of the wood, particularly from the root. A decoction of the bark yields a yellow dye, and, with coppers, is used to dye black. "The timber of the hawthorn is often spoiled through inattention after cutting. If it be allowed to lie in the tree it soon heats, and becomes quite *frush* (brittle) and worthless. It therefore ought to be instantly cut up into planks and laid to dry."||

5684. The ancients were acquainted with the hawthorn as a fence. The Greeks called it *pyracantha*, or fire-thorn. With regard to the antiquity of fencing with thorns in our own country, it is probable that fields were fenced with thorns before Queen Elizabeth's time, and not so late as the end of the 17th century; as appears from a quotation by Marshall from Fitzherbert, when the latter complained, at the beginning of the 16th century, of landlords enclosing, and thereby shutting out their demesnes and meadows from the use of their tenants.¶ According to Dr Walker, the first hawthorn hedges planted in Scotland were on the road leading to Inchbuckling Brae in East Lothian, and at Finlarig at the head of the Tay in Perthshire. They were planted at both places by Cromwell's soldiers.**

5685. Other plants than the hawthorn have been recommended to be used for fencing fields. No doubt others, such as the black-thorn, the crab-apple, the beech, the elder, and all the forest-trees that bear pruning, might form such a fence as to mark the division of one enclosure from another; but unless the plant so employed is furnished with spines, it will prove a very inefficient fence against the outbreaks of cattle and horses, irrespective of the trespasses of evil-disposed persons. The holly, *Ilex aquifolium*, is the only other plant that possesses the properties of a good fencing plant. It is durable, firm, stands pruning, is highly defensive, and verdant alike in all seasons; but, being very slow of growth, it would require a long time to attain a sufficient height for a fence, and, in the mean time, would incur much expense in its protection. It will, therefore, never become a substitute for the hawthorn for field-fencing, however beautiful a fence it may form near a dwelling-house or shrubbery. The cock's-spur thorn,

* Phillips' *Sylva Florifera*, vol. i. p. 261-4.

† *Beauties of England and Wales*, vol. xiii. part i. p. 504-5.

‡ Loudon's *Arboretum et Fructicetum*, vol. ii. p. 337.

§ Cruickshank's *Practical Planter*, p. 394.

|| Sang's *Nicol's Planters' Calendar*, p. 89.

¶ Marshall's *Rural Economy of Yorkshire*, vol. i. p. 46.

** Walker's *Essays*, p. 53.

Crataegus crus galli, and the Virginian thorn, *C. Virginiana*, have been proposed; but neither possesses any properties superior to the common kind. The juniper, *Juniperus communis*, and the whin or furze, *Ulex Europæa*, have been recommended. The whin does not stand severe frost. In the spring of 1837 almost every whin-hedge in Scotland was destroyed from this cause. The tala plant, a small thorny shrub, a native of South America, has been recommended as a good field-fence; but there is much doubt of its thriving in our climate. In Germany the hornbeam, *Carpinus betulus*, is used as a field-fence. In Holland, it seems that nurserymen have ready-made hedges for sale. "We have seen," says Dr Neill, "that a Dutch merchant, retiring from business, may purchase fruit-trees which will yield him their produce the very first year; we found that he may also surround his garden and shrubbery with ready-formed hedges! We observed many lines of different evergreen and deciduous shrubs, usually employed for this purpose, trained hedge-wise in the nursery; and these, like the fruit-trees, being frequently removed from one spot to another, may, almost without hazard of failure, be transferred to a considerable distance, and replanted."* I have seen the common spruce, *Abies excelsa*, clipped into very neat hedges. Hindoostan possesses a great variety of plants fit for field fences, but whether any one of them would thrive in this country remains to be proved. It is probable that the temperate region of the Himalaya may afford some useful hedge-plant.

5686. There are various ways of treating the hawthorn as a fence. In Yorkshire double hedges are not uncommon, the plants being planted in double rows upright in a trench in the soil. Double hedges were not uncommon in Berwickshire and Roxburghshire some years ago, but no new ones have been added to these. In Norfolk, a high bank is thrown up, without a wall, from 6 to 7 feet in height from the bottom of the ditch, and the thorn-plants are set into the top, among the crude earth taken out of the bottom of the ditch. As might be expected in such a plan, it is not uncommon in that country to see the face of the bank, with the quicks in it, washed down by beating rains; and as the roots enlarge and the bank moulders down, the young plants hang their heads downwards upon the face of bank. The reason assigned for the adoption of this objectionable practice is, that there is no wood in that country to form temporary fences until the thorns grow; and, being set upon the top of a steep bank, they are out of the reach of cattle from the bottom of the ditch. Where flat stones are plentiful, a sheltering fence is formed by enclosing a space of a few feet in breadth between two walls, and, on filling it with earth, an upright hedge is planted in it. Such fences may be seen in Devonshire, where flat stones of the primitive clay-slate are obtained in abundance. A 2½ feet wall on the top of the bank behind the hedge, which had been thrown out of the ditch, with a coping of turf, is recommended. There are objections to this plan: a turf coping on a

stone wall never grows well, and, in consequence, becomes an eyesore; and a wall founded on loose earth will remain even but for a very short time, on account of the unequal subsidence of the earth, and the consequent sinking of the stones. A 3 feet stone wall, founded upon the hard ground, behind the hedge-bank, with a single rail of paling raised behind it, until the hedge get up, would make a better fence for sheep and cattle. Another mode of planting a thorn-hedge is to build a stone wall, in which are left holes, about two-thirds of its height, through which the thorns grow which had been planted in the bank of earth behind it. This is also an objectionable mode, inasmuch as the plants, whose roots are ramifying in the bank, have no support for that portion of the stem which grows horizontally through the holes of the wall; and the consequent leverage of the part of the stem which grows upright before the face of the wall shakes the roots. And should the horizontal stem within the hole rest for support upon the wall, its weight and motion soon bring it down, if constructed of dry stones, or shatter it, if built with mortar. Thorns have been recommended to be planted at the bottom of a wall without a bank, but with a ditch before it as a fence to the hedge, with a paling on its lip. If a stone wall is built in such a situation, there seems no use at all for the hedge as a fence; and if a turf one, surely the thorns will thrive better with a bank of earth behind them than at the bottom of a turf wall.

5687. On considering the state in which the fences are usually kept, it must be admitted that the plan of enclosing the land is generally good; but the fences are not cared for as they might be. The low country is sufficiently, and, in many places, too densely fenced—too much ground being occupied, to the detriment of the crops growing within them. A slight glance at the small enclosures of England will convince any one of this, though the smallest enclosures are perhaps occupied by meadows of permanent grass. In the north of Ireland the enclosures are too small, though there the universal practice of small holdings better justifies the prevalence of small enclosures. The upland districts are very deficient of enclosures throughout the kingdom. Most of the hill-farms have even no march-fences, the marches being marked out by natural objects, such as the water-shed line of a hill, the course of a rivulet, a ravine, or even cairns of stones. The great desideratum, however, in such farms is shelter, which cannot be afforded by any single fence in such situations. The shelter of upland districts can hardly be accomplished but on a scale that would render it of national importance; for the attempt on a comparatively small property would confer as much benefit on the property on each side of it as on itself, and the proprietor of a large estate would not incur the great expense of sheltering it entirely. It would be desirable were proprietors of upland districts to have a mutual understanding on this subject, and plans could then be adopted which would have the

* Neill's *Journal of a Horticultural Tour*, p. 204.

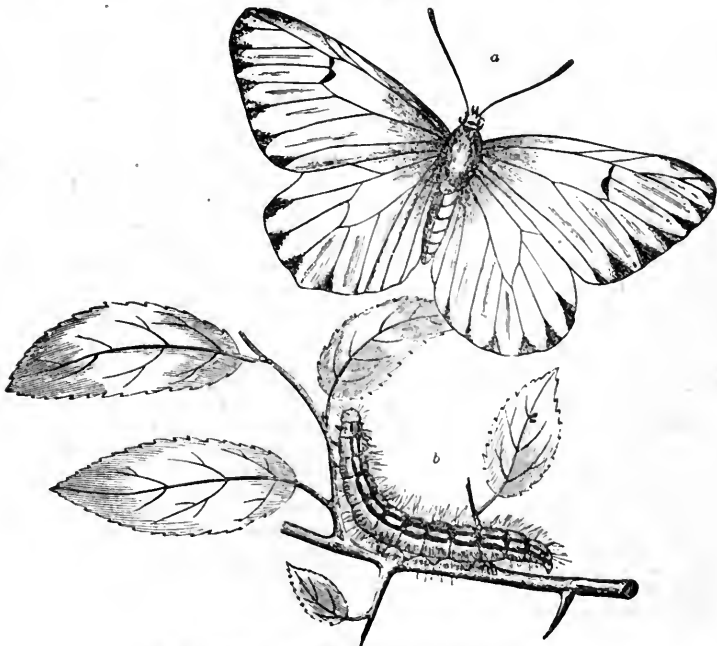
effect of sheltering a great extent of country at a comparatively small cost. Were extensive surveys taken of the form of alpine country, by engineers well acquainted with the prevailing winds there, and competent to suggest lines of fences which would be sure to check their course, estimates could be made of the cost; and no class of engineers seems better suited for the purpose than those engaged in the trigonometrical survey of the country. When the thorn-fences of the country are minutely examined, they will not be found always in a useful state. Some are allowed to grow in a rambling state, carrying a heavy head and exposing bare stems near the ground; others are far advanced in old age, and about to decay for ever, or covered with lichens and mosses; full of gaps, filled up with slabs, paling, or loose stones; occasionally overflowed with water, which gets leave to pass off of its own accord, which it can seldom do in winter before another flood overtakes it; completely overgrown with every weed that gets leave to shed its seeds for miles around; almost overcome with wild plants, which have usurped the place of the thorns; so hacked and hewed with the hatchet, that the greater part of it is a long time of recovering the butchery, whilst the remainder have died in consequence of the rain descending the split stems and rotting the roots; so overlaid with plashing, that the already half-amputated stems die in a short time; suspended by the principal root, after the earth has been washed away from it into the ditch; cut over too high, where it has put out innumerable twigs, whilst the stems below are quite bare; so shaken

at the roots, when left exposed for want of water-tableing, in consequence of the wind acting on them, by the leverage of its high stems, that after it has been cut down it dies for want of power to push out new stems. Such is the sort of treatment which thorn-hedges generally receive.

5688. The only accident incident to young hedges in spring is scorching from the sun. It is occasioned by the sudden evaporation of hoar frost, in a calm atmosphere, from the young leaflets of the hedge, by a powerful rising sun. The sudden evaporation causes so intense a cold as actually to destroy vitality in the tender shoots of the plant which have just burst into leaf; and the consequence, in a few days afterwards, is in the young leaves and tender shoots seeming to have been severely scorched by fire. I have frequently observed this scorching, to a partial extent, on the east sides of hedges that run N. and S., the side next the rising sun; but in spring 1841, the affection was so severe and extensive, that not hedges only suffered, but large beech-trees of upwards of 100 years old, that came early into leaf, literally died in the ensuing winter. A hedge so affected will be leafless all summer at the part scorched. It ought not to be switched until it has perfectly recovered its vigour.

5689. The thorn-hedge is subject to the attack of many insects, though the effects are different. One of these is the black-veined white, or hawthorn butterfly, *Pieris crataegi*, a, fig. 475, an in-

Fig. 475.



THE HAWTHORN BUTTERFLY—PIERIS CRATEGL.

sect unknown in Scotland, but frequent in England, and at times so numerous on the Continent that its flight has been mistaken for a shower of snow. The caterpillar is seen at *b*, of a dull yellow colour at first, but changes with moultings, and is produced from yellow-coloured cylindrical eggs laid on hawthorn shoots, and rendered waterproof by a coating of strong varnish. It devours the leaves, and, while so employed, lives in society under the protection of a silken web. Other lepidopterous insects disfigure our hedges by defoliation, such as the figure of 8, or black thorn moth, *Episema carulocephala*, whose caterpillar is 2 inches long, of a yellowish-green colour, with 3 pale stripes. A still greater pest to our hedges is the brown-tailed moth, *Porthesia auriflua*, whose caterpillars, of a dusky colour, with 2 red lines on the back, and a white streak on the sides interrupted at intervals, occur sometimes in such numbers that, in 1782, their webs were gathered in one day by the people of a single parish in the neighbourhood of London, that of Clapham, to the amount of 80 bushels.* Another species of the same genus *Porthesia chrysorrhæa*, yellow-tailed moth, lives on a great variety of trees and shrubs in its caterpillar state; and among these is the hawthorn, to which it often causes extensive injury. The small and beautiful ermine moths, so readily known by their pure white colour, generally spotted with black, often leave the fruit-trees, which are their habitual resort, and attack hawthorn hedges. The caterpillars live in society, and form a common tent for themselves by drawing a number of leaves together, which afford them at once food and shelter. Having consumed the foliage of one spot, they move on to another; and the devastation is often so complete that the hedges, for miles, present the appearance of winter sprays covered with a cottony web. The two species most to be dreaded are *Yponomeuta padella* and *Y. eronymella*. They are more common in England than in Scotland.

5690. As hedges of whin, *Ulex Europæa*, are common in the upper and poorer parts of the country, it is necessary to say a few words on them. Whins—or furze, as the plant is named in England—are very frequently sown upon the top of a turf mound constructed for the purpose, because the young plant is out of reach of danger, and requires no temporary fencing for protection, and where, generally, turf is plentiful. The plants grow well in such a situation, striking their roots down through the mound into the ground below, for the sake of meeting with moisture. No doubt, the sharp spines of the plant attract moisture from the atmosphere as well, as the structure of the plant is well adapted for causing the rain to trickle down the branches to the roots. In raising a whin fence, all that is required to be done is to sow the seed, which costs 1s. per pound, along the line of fence, in a small rut made with the corner of the hand-hoe, fig. 266, and covered over with a rake. The seed

may then be sown upon a prepared mound, as on the prepared level of the ground. The plant grows very rapidly, and soon becomes a fence from its spiny armament. It should be switched into the proper form of a hedge when young, to prevent the straggling form of growth which it is very apt to assume. When allowed to grow at will, it attains a mature age in a few years, and then dies out, or it is hastened to its end by the frost. The whin does not like very good soil. I tried to raise a hedge upon a small mound of fine black mould, but failed by the young plants dying out. My object was to have a whin hedge for drying clothes upon, as that plant exposes the most convenient and safe surface, by its small spines, for receiving clothes upon it. The plant likes to push its roots into a clay subsoil. The whin forms a cheap fence around a plantation, and it forms a good nurse for young trees not over-thickly planted, and is well adapted as underwood to afford shelter to game. The late Mr Inglis well described the utility of the whin plant in these words: "In returning to Wexford by another road, I was greatly struck by the gay effect produced by the furze, or, as they are called in Scotland, the whin hedges, which form the only enclosures in this district. The furze hedges are very general in Ireland, and are much preferred by the people to any other, and not without reason. In parts of the country where turf is scarce and coal dear, the furze is a ready and abundant fuel. Nor is this the only use to which it is put—the tender shoots are mashed, and given as food to the horses, and the refuse is mixed up, and used as manure. There is still another use of a furze hedging: when full grown, it affords, in rainy weather, a shelter to live stock, which neither thorn nor any other hedge affords; for there are no droppings from a furze hedge. This is a fact of which any pedestrian may agreeably convince himself, if caught in a shower of rain, in the neighbourhood of a furze enclosure." †

5691. Mr Fortune mentions a curious method which the Chinese have in protecting the young bamboos from the ravages of the wild boar: "A piece of bamboo wood about 8 or 10 feet long, and rather thicker than a man's arm, is split up the middle to within a fourth of its length. This is made fast to a tree in the bamboo thicket, and at an angle of about 45°, the split part being left loose; a cord, a'so made of bamboo, is fastened to it by one end, and the other is led to some convenient place out of the thicket, where a man is stationed. When the boars come down in the dead of night to attack the young shoots, the man pulls the rope backwards and forwards, and clank, clank, clank goes the bamboo, producing a loud and hollow sound, which on a quiet evening may be heard at a great distance. The animals are frightened, and make off to their dens in the hills." ‡ Our crow-mills, or great rattles, would probably produce the same effect when sprung in the hands of a stout watcher.

* *Quarterly Journal of Agriculture*, vol. xiii. p. 155.

† *Inglis' Ireland*, vol. i. p. 50-1.

‡ *Fortune's Wanderings in China*, p. 179.

ON THE BUILDING OF STONE FENCES..

5692. The other sort of fence for the fields, used in this country, is the low dry-stone wall. They are named dry-stone dykes in Scotland; and as the word *dyke* is short and expressive, I shall use it more often than *wall*, with which the idea of a high structure is mostly associated.

5693 Very many dry-stone dykes in this country are constructed on erroneous principles, the stones being laid promiscuously, and more with a view to give a smooth face than a substantial hearting to the wall. The coping, too, is often disproportionately large for the body of the wall, which is not unfrequently too narrow for its height. I suspect that many dry-stone dykes are built by ordinary masons, who, being accustomed to the use of lime-mortar, are not acquainted with the bedding of the loose stones of a dry dyke as firmly as they should be, and therefore are unfitted to build such a dyke. A builder of dry-stone dykes should be brought up to the profession; and when he has acquired skill he will build a substantial one, at a moderate cost, which will stand upright for many years. A proper sort of stone is a great assistance to the builder of stone dykes, flat thin ones being the best: but flatness and thinness are not the only requisites; they should also have a rough surface by which to adhere to one another in the wall; and no material, on this account, is so well adapted for the purpose as the stones derived from sandstone boulders of gravel deposits, when split with the pick into flat pieces of the requisite thickness on being taken out of the ground, which, on being exposed to the air for a short time, become dry and hard.

5694. Dry-stone dykes are measured by *quarters*—that is, quarters of a yard of 9 inches each. A 5-quarter dyke is the usual measure of a field-fence, that is 45 inches, or 3 feet 9 inches to the under side of the cover upon which the cope-stones stand—the cover and cope-stones usually measuring 12 inches, so that the dyke stands altogether 4 feet 9 inches in height. The dyke, when finished, is measured by the rood of 36 square yards upon its face under the cover, so that

every 30 yards of a 5-quarter dyke will be 1 rood in length. The usual thickness of such a dyke is 2 feet at the base, and 15 inches under the cover.

5695. A dyke that has two plain faces is called a *double-faced* dyke, and a dyke with one face, as one built against a sunk-fence, is called a *single-faced* dyke. A double-faced 5-quarter dyke requires 1 ton of stones for every square yard of its face, so that 36 tons of stones are required for every rood of 30 yards long. The expense of quarrying that quantity of stones is about 10s. the rood; the carriage of them at a reasonable distance beyond one mile is also 10s; and the building is commonly undertaken, when the stones are good, at 10s. also; so that such a dyke costs 30s. the 30 yards, or 1s. for every yard in length, or £6, 9s. 6d. per cubic rood, or 3s. 7d. per cubic yard. The best way to contract for the erection of stone-dykes is by the rood of 36 cubic yards, when every temptation on the part of the builder to lessen the breadth, and make the heart of the dyke hollow, will be removed.

5696. The tools of a dry-stone dyker are few and inexpensive, consisting only of a mason's hammer, a frame as a gauge for the size of the dyke, and cords as guides for the straightness and thickness of the dyke. A ditcher's shovel, fig. 453, is also useful to him in putting the shivers of the stones together into heaps, to be the more easily removed by carts.

5697. A dyker cannot work in wet or in very cold weather, as handling stones in a state of wetness is hurtful to the bare hand; on which accounts, dry-stone dykes are commonly built in summer.

5698. The line of fence being determined on, it is marked off with a row of stakes driven firmly into the ground. The upper soil, to the depth it has been ploughed, is removed from the line to form the foundation of the dyke; and it may be driven away immediately, and not lie in the builder's way, or it should be formed into a compost with lime, near the spot, for top-dressing grass. When the surface consists of old firm thick sward, the dyke may be founded

upon it; but in forming foundations, it should be borne in mind that dykes are apt to sink in *soft* earth of every kind, to its injury—not merely by curtailing its height as a fence, but by twisting its structure and causing it ultimately to fall. When the soil consists of vegetable *mould*, it should therefore be removed altogether, and its intrinsic value in a compost will amply repay the trouble of removing it.

5699. After the foundation has been formed by the removal of the earth, the stones should be laid down on both sides *as near the line of foundation as practicable*, for it is of considerable importance to the builder that the stones be near at hand. When the stones are laid even as far off as two yards, from the foundation, the builder loses time in throwing them nearer; but, on the other hand, no stones should be emptied from the cart into the foundation, as they will have to be removed by the builder before he commences his work. Large boulder-stones form excellent material for the foundation of stone dykes, and should be laid close to the foundation before the building stones are brought. In laying down the stones, the carters should be instructed to put down 18 tons on each side of 30 yards length of the foundation; and when boulders are also put down, allowance should be made

for them out of the building stones. These particulars are worth attending to, to save unnecessary trouble afterwards in removing or bringing stones, to the annoyance alike of the dyker and the farmer.

5700. The simplest mode of conveying large boulders is upon a sledge, shod with iron, which is better than putting them in and taking them out of a common cart, the bottom and sides of which are apt to be broken by boulders. A pair of horses, yoked as in a plough, will draw a very heavy boulder upon such a sledge, on the ordinary surface of the ground. When many ordinary stones are driven for buildings, of any kind, the carts should receive an extra bottoming and lining with deals of common Scots fir, or of willow, which is better than any other sort of wood, as being softer and less liable to split.

5701. Every preparation being thus made, two builders proceed to the work, one opposite the other—the best number to make the best work, and they assist each other with stones which one would not be able to manage.

5702. They begin by setting up the frame, fig. 476, at one end of the dyke, whether it commences against another

Fig. 476.



THE BUILDING A DRY-STONE DYKE.

fence, or at a gateway into the field which the figure is supposed to represent, in the foundation of the proposed line of dyke. The frame is made of the breadth and height of the proposed dyke under the cover; and is set perpendicularly by the plummet attached to it. A corresponding frame should be placed beyond the point which is fixed for one stretch of building, or two stakes driven into the ground, having the same inclination as the sides of the frame, to answer the purpose of a temporary one. On undulating ground, a space of half a rood, or 15 yards, between the frames, is a sufficient stretch of building at one time; but on level ground a rood may safely be taken in. The cords are then stretched along the space, and fastened to the outside of each frame, to guide, as lines, the building of the side of the dyke straight, and to gauge its breadth. The frame is held upright and steady by a stiff rail, having a nail driven through one of its ends, hooked on to the top-bar of the frame, and the other end with a stone laid upon it, or pushed into the ground.

5703. When the dyke begins with a scuncheon, as in this case, a large boulder should be chosen for its foundation stone; and if there are no boulders, a large stone should be selected and dressed for the purpose, as no better protection can be given to the end of a dyke—and especially so when the scuncheon forms one side of a gateway to a field. Another boulder, or large stone, should be placed at a little distance from the first, and smaller stones used to fill up the space between them, until the building is raised to the height of the boulders.

5704. Great art is required in laying the small stones, and it is this art in dyke-building which detects the good from the bad builder. In good dry building, the stones are laid with a slight inclination downwards, from the centre of the dyke, towards each face, and to break band with one another; and to support their inclination, small stones should be wedged firmly under them in the heart of the dyke; whereas stones that are laid flat admit of no wedging to heart them, and receive none, to the risk of the dyke bulging out in both faces. The inclination causes the

rain which may have found its way down through the top of the dyke to be thrown off by both sides.

5705. The stability of a dyke is much assisted by having what is called a *thorough-band* stone, placed across it at about half-way up the building. The cover also acts as a thorough-band at the top of the dyke; but in laying the cover, the *levelling* of the dyke to form its bed should not be made of very small and very thin stones, as is too often the case, as neither have stability, are easily broken, and are constantly in danger of slipping out from under the cover and cope. Thorough-band stones are frequently left projecting from one or both sides of the dyke by some builders, merely to indicate that they are thorough-bands; but the practice is objectionable, inasmuch as any projections serve only as stepping-stones for trespassers to climb over the dyke.

5706. A scuncheon should be formed of in-band and out-band stones, hammered, and firmly bedded upon one another.

5707. The *covers* should project an inch or two beyond the face of the dyke, to protect the top. They should be two inches thick, and without a flaw throughout their length, which should be two feet at least, that their weight may keep them firm and their size cover a large space of building.

5708. In forming the *cope*, a large stone should be placed at the end of the scuncheon to keep down the cover, and act as an abutment for resisting the wedging down of the smaller cope-stones. Another large cope-stone should be set at a short distance from it upon the joining of two covers, to keep them secure. Thinner stones should then be placed between these on edge—and where they meet, a stone should be wedged in by strokes of the hammer; but the *wedging* should be delayed until a considerable length of coping is finished, the better to resist their force. The cope-stones should be nearly all of the same height. On finishing the *face* of a dyke, small stones should be firmly wedged in with the hammer, where room can be found,

between the beds and the ends of the larger ones.

5709. In building a stretch of dyke, such as the rood above referred to, it is customary to carry up the building at both ends, as well as at the middle of the stretch, to the levelling of the top, before the intermediate spaces are built up, because those primary parts, being built thus independently, act as pillars in the dyke to support the intermediate building plumb; and they are also convenient for pinning the cords against while the intermediate spaces are being built.

5710. When a few stretches of dyke have thus been finished, the surplus stones, if any, should be removed, and laid where they are wanted; and should there be a deficiency, stones should be immediately brought, to allow the builders to finish one stretch before they proceed to another. The debris of stones caused by the hammer should be taken to the roads.

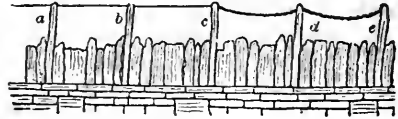
5711. These are all the particulars to be attended to in building dykes for ordinary fencing; but modifications are sometimes introduced into their form to serve a convenient purpose. For example, an opening should be left under the cover of a dyke, of a sufficient width and height to allow sheep to pass from one field into another, when the passage between them by road may be a considerable distance. Where a passage exists between the fields by means of a gate, no such opening should be made, but only when the two fields are entered by different farm-roads. When the opening is not used, it should be stopped up with thorns or a wooden board. An opening of $3\frac{1}{2}$ feet wide and 3 feet high will suffice.

5712. Another convenience is to leave a gap at the top of the dyke by lowering its cover, and removing the cope at a place where a passage is occasionally required for foot passengers. By doing this the dyke may be saved from much injury. A gap near the top of the dyke may be useful as a stile in the line of a foot-path, or at the side of a cover, for hounds and huntsmen to pass with ease; and here the whipper-in may stand on the out-look for a burst. When not constantly in use, the

gap is easily fenced with a bunch of thorns or whins.

5713. Such dykes as I have been describing, of 5 quarters in height, will fence horses and cattle and Leicester sheep, but will not confine Black-faced sheep, and scarcely Cheviots. For these, higher walls must either be built, or expedients used to make ordinary ones confine them. Some of these expedients are shown in fig. 477, where part of an ordinary dyke

Fig. 477.



EXPEDIENTS FOR INCREASING THE HEIGHT OF A DRY-STONE DYKE.

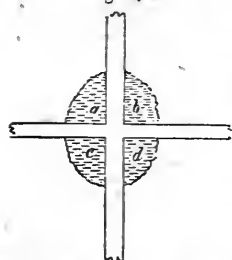
with its cope is seen; and they consist of occasional cope-stones *a b c d* and *e*, set on edge to a considerable height, say 9 inches or 12 inches, above the ordinary ones. Upon these are placed either fillets of wood along notches formed on their top, and wedged into them, as at *a, b* and *c*, or a strong rope of straw is laid somewhat loosely over the notches, to dangle in the wind, and to form a scare to the sheep, as at *c, d* and *e*. Another expedient is, where a single-faced dyke is built against rising ground, consisting of plantation or of cultivated land, to sow a few seeds of whin or broom in the soil behind the dyke, and the plants in time spread over the cope-stones. Where good stones for covers are scarce, and turf is tough and heathery, thick turfs, cut of the breadth of the top of the dyke—and laid firmly and neatly on with cope-stones upon the turfs, which afford them a firm bed—will raise a dyke a sufficient height. A more permanent expedient than either of these, where the dyke is built of large strong stones from a quarry, is to erect a wire fence upon the dyke, by inserting upright wrought-iron standards into the covers, and stretching three rows of wire through and across them. Such an addition costs from 8d. to 1s. 4d. per lineal yard. Or stakes might be driven along and close to one face of the dyke, in length to reach above its covers to receive three rows of wires. Where thinnings of plantations are abundant, this is the cheapest, though less

durable plan than the preceding ones with the wires.

5714. When dykes run at right angles to one another, and are erected simultaneously, they should be built in connection; but where a new dyke comes against another, the old one should not be touched, and the new built firmly beside it.

5715. Where two dykes cross, and the place is naturally wet, or water may be easily brought to it, a watering-pool there would serve four fields, and the pools should be formed before the dykes are built. There are two ways of fencing such

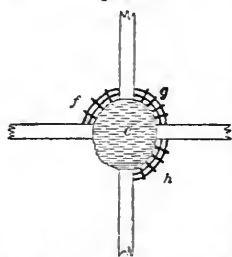
Fig. 478.



FOUR WATERING-POOLS
 FORMED BY TWO DYKES
 CROSSING.

a pond: — When the ground is firm, and the water shallow, the two dykes may cross at the centre of the pond, as in fig. 478, having holes in them to allow the water to pass through, to form a watering-pool in each field, as at *a*, *b*, *c*, and *d*.

Fig. 479.



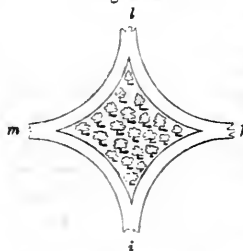
ONE WATERING-POOL COM-
 MON TO FOUR FIELDS.

5717. Where the ground is firm, and no prospect of obtaining a watering-pool, the dykes should be made to cross, and a well sunk in a corner of one of the fields, with a pump in it of such height as to

supply all the fields with water from it by means of a spout into troughs. This expedient I have successfully used.

5718. Where the ground is firm, and no water but shelter is wanted at that spot, the dyke should be built curved, to enclose a space between them to be planted with trees for ornament and shelter. The land here will not be wasted, even should it be of the finest quality; because the corners of four adjoining fields always contain ground that cannot be reached by the plough, as may be seen between *i*, *k*, *l* and *m*, fig. 480;

Fig. 480.



A CLUMP OF TREES WITHIN
 THE MEETING OF DYKES.

while the plough can pass along such curves as near as to a straight fence. In building curvatures in dykes, builders charge a half more per rod than for plain work. Such curves in dykes are made by the same rules as those furnished for hedges in (5621.)

5719. A stone dyke is in the highest state of perfection as a fence immediately from the hands of the builders; but every day thereafter the effect of the atmosphere upon the stones, at all seasons, and the accidents to which they are liable by trespasses of individuals and the strength of stock, render it necessary to uphold their repairs frequently; and this consideration should cause the best materials and workmanship to be selected for their original erection. Dykes should be inspected every year, before the stock take possession of the pasture fields, and repaired, (3570.) When the repairs are not extensive, the most convenient mode of supplying the stones to the dyker is to loosen a cart-load of them here and there, and provide him with a wheel-barrow, fig. 87, to take the stones from it to the particular spot requiring repairs, as he wants them; and what he does not require are left in the cart to be brought away at once. When stones are laid down, it being impossible to estimate the quantity exactly required, those not required are almost certain to get leave to lie upon the ground

for the greater part of the ensuing season, from the reluctance to waste time in doing such an insignificant job at a busy season, as the removal of a few stones.

5720. Dry-stone dykes are not nearly so picturesque objects in a landscape as thorn hedges, nor do they afford so much or so comfortable shelter to stock, (1013.) They are easily and quickly erected, however, in a country where the materials suited to their construction are abundant; and after being completed, they satisfy the mind of the farmer that little trouble will be experienced from them for a series of years to come.

5721. A sunk fence cannot be said to have been formed until a single-faced stone dyke is built against the firm ground, after the earth had been taken away in front of it; and no better means can be employed anywhere for supporting a bank of earth likely to slip down than by building a strong single-faced dyke against it. Such a face dyke may be built, including the quarrying and carriage of the stones, for 9½d. per lineal yard.

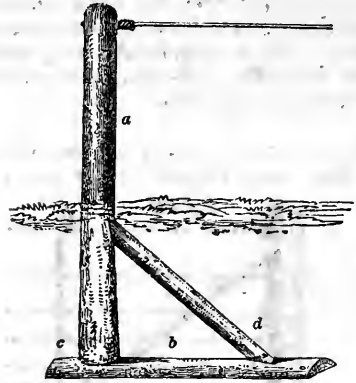
ON WIRE FENCES.

5722. A good many years since, I first saw a wire fence at the late Sir Alex. Muir Mackenzie's, at Delvin. The structure was neat, but then very costly; but now that wire is manufactured on a large scale, on purpose to construct this species of field fence, the price of wire-fencing has been greatly reduced, as is the case with all manufactures for which there arises a large demand.

5723. Wire-fences consist of three parts—the straining-posts, the standards or intermediate posts, and the wires. The *straining-posts* are made of wood or of iron; and in the country, where wood is cheaper than iron, the former will in most cases be chosen, although it can bear no comparison with iron in durability. A simple form of straining-post is shown in fig. 481, where *a* is the post 7 feet long, and 6 or 7 inches in diameter at the smallest end, is put into a pit 3 feet deep; *b* is the sole 6 feet long, 3 or 4 inches thick and 6 inches broad, which takes in the

post *a* at 6 inches from the end *c*, and has a notch cut into its upper surface near the

Fig. 481.

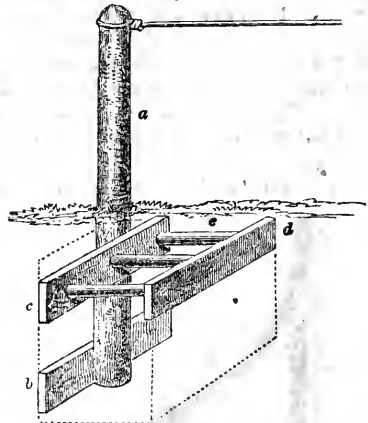


STRAINING-POST, WITH SOLE AND STAY UNDERGROUND.

other end to admit the strut *d*, which is also notched and nailed into the post about 4 inches below the surface of the ground. In setting the post into the ground, the earth is firmly rammed in upon the sole, and about the strut.

5724. Another method of securing a straining-post underground is shown by fig. 482, where *a* is the post of the same

Fig. 482.



STRAINING-POST, WITH PLANKS UNDERGROUND.

size as the preceding, at the back of which at the bottom, is fastened a plank *b*, 2 feet long, 10 inches broad, and 2 inches thick; and another plank *c*, of the same dimensions, is fastened in front of the post about 6 inches below the surface of the ground. The earth is then firmly rammed in until

it comes to 12 inches of the surface, when another plank *d* of similar dimensions is placed opposite to the plank *c*, firmly into the ground, and then the three pieces of wood *e* are tightly driven in between the planks. This is considered a very secure mode of fixing a straining-post against the tension of the wires.

5725. A third method still is given in fig. 483, where a similar size of post *a*, to

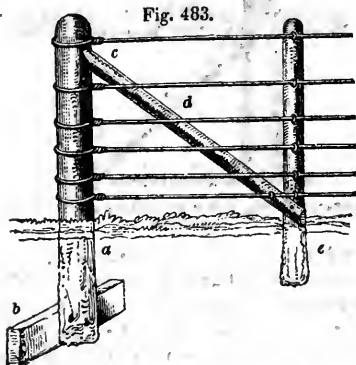


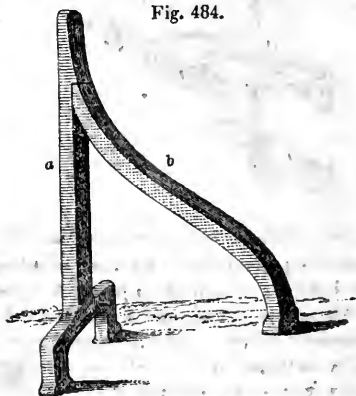
Fig. 483.

STRAINING-POST, WITH STANDARD AND STAY ABOVE GROUND.

the others, is placed in the pit, having a piece of wood, *b*, 2 feet long, 6 inches broad, and 2 inches thick, nailed to the back part of the bottom; *e* is a standard driven into the ground, at 4 feet distance, and the strut *d* is nailed at one end into a notch near the top of the post at *c*, and at the other end to the standard *e*, near the ground. Both the posts are fixed in the ground before the strut is nailed to them.

5726. Another sort of straining-post is

Fig. 484.



A WROUGHT-IRON STRAINING-POST.

made of wrought iron, fig. 484. When wooden straining-posts decay they must be removed, and in doing which the whole fence must be taken down. Iron posts, such as *a*, obviate this inconvenience by being permanent. They are $1\frac{3}{4}$ to $1\frac{1}{2}$ inch square, and cost from 2d. to 2½d. per lb. Each weighs from 32 lb. to 40 lb., according to the height required. The extreme posts require a stay, *b*, in addition, which costs according to its weight. The cost of a straining-post is this:—

34 lb. at 2d. per lb.,	£0 5 8
Boring in a stone 2 holes, $3\frac{1}{2}$ inches deep,	
and 2 inches diameter, a whinstone,	0 0 9
5 lb. lead for batting, at 2d.,	0 0 10
	<hr/>
	£0 7 3

Boulders answer for blocks, if not under 10 or 12 cwt.; and those which have rounded tops are best, inasmuch as a greater depth of earth covers them, to the benefit of the grass growing over them.

5727. Mr Binning Munro of Auchinbowie, Stirlingshire, uses only iron straining-posts and iron standards, and considers them as cheap as wooden ones, even at first. His straining-posts are round, $2\frac{1}{2}$ inches diameter, with stays, and weigh 68 lbs. The standards are made of $1\frac{1}{2}$ inch by $\frac{1}{2}$ inch bar iron, with 6 holes for the wires, and weigh 10 lb. each, and they are not squared at the ends, to admit them being put into a small hole, as is commonly done, and which weakens the iron, where it should be the strongest, but are kept broad and flat; and the hole is made for them, and not they for the holes. The straining-posts have a hold in the stem of 6 inches, the standards 4 inches. After the posts are put into the holes, these are filled with round gravel and melted sulphur run amongst them, at 2d. per lb., which is better than lead, because it does not shrink as lead does, and become loose.

5728. The intermediate posts should be made of larch, and the thinnings of plantations are suitable for them. For a fence of $3\frac{1}{2}$ feet in height, the posts should be $5\frac{1}{2}$ feet long, with a diameter of $3\frac{1}{2}$ inches at the smallest end. In ordinary fencing, they may be used with the bark on. They should all be charred, which is done in

this manner:—Lay two trees of little value parallel, about a foot or fourteen inches apart, upon the ground. Between them collect chips and brushwood, and set fire to them. Lay the posts directly across the flame, at the part where the surface of the ground will touch, and turn them from side to side until they are ready. They are then smeared with coal-tar as long as they are warm, that as much as possible of it may be absorbed.

5729. Intermediate posts have a sufficient hold of the ground at 21 inches deep, and will support the wire sufficiently when set 7 or 8 feet apart, in a straight line; but in curves they should be set closer, and always within the curve, to meet the strain upon the wires. The staples for supporting the wires are partially driven into the posts before these are set into their pits.

5730. The wires used in wire-fencing are of different kinds, and bear different names. They are named common, prepared, charcoal, and annealed wires. The common is the ordinary wire of commerce, and is the kind which has hitherto been mostly employed in wire fences. It is made from the coarser sorts of iron, and, as its name indicates, bears a corresponding relation, both as regards quality and price.

5731. Prepared wire is made from a finer description of iron, is more carefully manufactured, comes out in longer lengths, is consequently superior in quality, and bears a higher price in the market.

5732. Charcoal wire is the best and strongest of any of the qualities made. It is drawn from charcoal iron, prepared chiefly by wood-charcoal, which is freer from the impurities known to deteriorate the quality of iron, that exist in a greater or less degree in all the fuels used in the manufacture of the other descriptions of that material.

5733. Annealed wire is the common wire softened in the furnace, and sent out in that state. It is purchased at the same price as the common, and is in some districts used in preference, from its being softer and more easily handled than the other. It is, however, the very worst that can be put into a fence, and ought

always to be rejected. It easily bends, and remains so from want of elasticity; and it soon oxidises, even when painted.

5734. The following table exhibits the comparative qualities of these wires, as tested by the number of pounds each kind sustains before breaking, the length being 10 feet:—

Common Wire.

No. 8 broke with	590 lbs.	} without perceptibly stretching.
No. 6	844	
No. 4	1269	

Annealed Wire.

No. 8 broke with	605 lb., stretched	4½ inches.
No. 6	832	3
No. 4	1262	2

Prepared Wire.

No. 8 broke with	955 lb., stretched	1 inch.
No. 6	1390	¾
No. 4	2163	½

Charcoal Wire.

No. 8 broke with	1274 lb.	} stretched the same as the prepared wire.
No. 6	1762	
No. 4	2656	

5735. These are the Nos. used in wire-fences. Each bundle of wire is made up of 63 lb., and each bundle runs thus:—

No. 4 extends from	140 to 150 yards.
No. 6	180 ... 200
No. 8	280 ... 300

5736. The cost of the different kinds of wire of the same size, from Nos. 1 to No. 6, is the same. No. 1 to No. 6 of common wire costs from 8s. 6d. to 10s. 6d. per bundle; the prepared is 2s. more, and the charcoal 2s. more than the prepared.

5737. The number of wires employed in a fence depend on its height, but the ordinary height of 3½ feet requires 6 wires to make the fence confine sheep and lambs. Fig. 483 shows a portion of a fence having 6 wires, the two upper ones above *d* being of No. 4, and the four below it, No. 6 wires. A not uncommon arrangement of the wires is to make the two uppermost No. 4, the two undermost No. 6, and the two intermediate, No. 8. The upper wire is first strained, and then the lowest one, and the intermediate ones are taken in succession, the tension of the upper one being the gauge to the others.

5738. As to the cost of wire-fencing, an

instance may be given of a fence constructed in front of a plantation, of curved and irregular form, of wooden posts and standards, $3\frac{1}{2}$ feet high, having 6 wires, and extending to 665 yards. The two upper wires were of No. 4, and the four lower of No. 6. The undermost one was 6 inches from the ground; the second, 11; the third, $16\frac{1}{2}$; the fourth, 23; the fifth, $31\frac{1}{2}$, and the uppermost, 42 inches. The cost may be stated thus:—

35 straining-posts and angle-posts, at 1s. 9d.,	£3	1	3
17 stays for ditto, at $4\frac{1}{2}$ d.,	0	6	$0\frac{1}{2}$
230 small posts, at $4\frac{1}{2}$ d.,	4	1	$5\frac{1}{2}$
1400 staples, at 1s. per 100,	0	14	0
10 bundles No. 4, prepared wire, and 15 bundles No. 6, at 10s. 6d. per bundle,	13	2	6
Wages for fitting up,	8	16	3

Equal to 665 yards at $10\frac{3}{4}$ d. per yard, £30 1 5 $\frac{3}{4}$

5739. Three wires above the height of a turf or stone dyke cost about $7\frac{1}{2}$ d. per lineal yard.*

5740. Mr Binning Munro's account of the cost of erecting a wire-fence with iron posts, per 100 yards, is this:—

3 bundles of wire, at 8s. 6d.,	£1	5	6
Iron for posts,	1	2	6
Boring and fitting posts,	0	10	0
Straining-posts bored and fitted,	0	6	6
Making holes in stones,	0	6	2
Other expenses,	1	0	0

Equal to 11d. per yard, £4 10 8

The stones being heavy, and the posts strong, no stays are required, and the iron work is put down at cost price and labour, the entire work having been done by country smiths.†

5741. The durability of wire fences is greater than might be expected. They stood upon the estate of Torrance, in Strathearn, for twelve years before requiring repairs, and then some of the standards were renewed, while the wire would stand for six years to come. On other estates they have stood nearly ten years without repair. Were the posts made of iron, they might stand a lease without repairs.

5742. It is not at all probable, that however durably wire-fences may be erected,

they will ever supersede thorn hedges or stone dykes on farms. They afford no shelter to stock, and, appearing insignificant to restless cattle in the fields, have been attempted to be leapt over, and the cattle, not marking the height well, have been caught by the upper wire in the groins, to their serious injury. They are well adapted to the fencing of plantations until the trees grow sufficiently high for pasturage under them. The grazings of pastoral farms might be subdivided by them, much to the advantage of both the stock and pasture. They would form a cheap mutual march-fence, even with iron posts, on large bill properties. They might be used instead of paling for protecting young thorn hedges, until they grow up to be a fence.

5743. Wire would make a neat fence between the plateau and a small grass field in front of a farm-house. Movable hurdles of iron might be conveniently used to confine a sheep or two to eat up the grass of a small plat and save the trouble of cutting it. Top-dressing the grass in this manner is preferable to cutting it with the scythe and carrying it away, to the impoverishment of the soil.

ON EMBANKING AGAINST RIVULETS.

5744. It is not safe to have no fence betwixt arable land and a rivulet. However peaceful and beautiful such a stream may be in summer, the haugh ground on its margin is subject to be overflowed by sudden floodings in winter, when surcharged with melted snows, or dammed behind piled sheets of broken ice, at the up-breaking of a storm. It may, therefore, be of service to you to be made acquainted with the means, in such circumstances, of preventing small streams, when flooded, from reaching ploughed land. Where haughs are kept in permanent pasture, comparatively little injury is sustained from floodings, but rather benefit from the deposition of alluvial matter; but to be prevented ploughing land, from the chance of the soil being carried off by water, is an inconvenience which no farmer should endure. In one season,

* *Transactions of the Highland and Agricultural Society*, March 1850, p. 244-62.

† *Journal of Agriculture*, July 1850, p. 428.

two acres of wheat on a fine haugh belonging to myself were completely carried off, soil and crop, by the sudden eruption of the small river Vinny, in Forfarshire, caused by the damming of the ice at a turn of the rivulet in the breaking up of a severe storm. The devastation seemed irreparable; yet in a short time afterwards, in spring, there being abundant depth of alluvial soil in the haugh, the large holes made, and the banks of soil thrown up by the water, were filled up and levelled, and the soil ploughed, manured again, and sown with turnips, as if no such accident had occurred that season. To prevent the recurrence of similar catastrophes, I made a small embankment along the whole line of the stream, at every place where it was possible for it to overflow, and which completely defended the soil from similar harm in future.

5745. To determine the dimensions of an embankment adapted to the peculiarities of the locality, you should beforehand ascertain, from the best evidence you can obtain, the *highest point* to which the water of the rivulet had ever reached; and if your embankment is made 1 foot higher than that point, your land may be considered as being placed in safety. The next consideration is the distance of the site of the embankment from the margin of the water. In every place where the bed of the stream is narrow, and where, of course, the flooded current will attain the greatest height, the embankment should not only be higher, but farther removed from the stream. Where the bed of the stream, on the other hand, is broad, and there is ample space for a slow though deep current; the embankment may be safely placed nearer the water's edge. But the safest plan in all cases is to afford ample space for the water, and much loss has been occasioned by contracting the channel of a river too much by embankments on opposite sides of it, from a mistaken desire to reclaim pieces of land from the river bank; forgetting that, in proportion as the river is increased in depth, by confinement between embankments on both sides, its power to do mischief is greatly increased—as much as even to overcome the strength of the embankment, when the injury committed will be of a much more

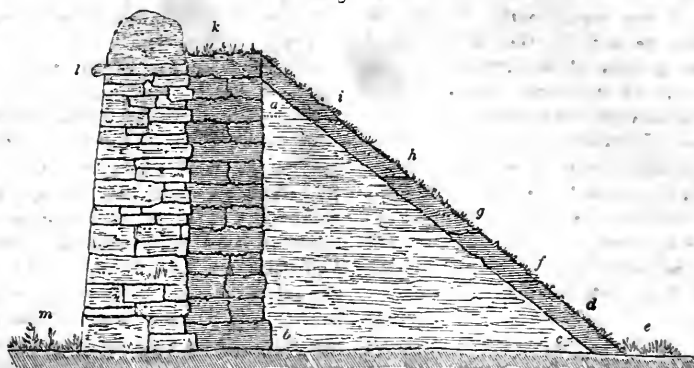
serious character than if their had been no embankment at all. The best policy is to give the river sufficient room to flow, and also to remove all sudden turns in its course, against which the water may strike with force, or be deflected with violence against the opposite bank. Let all the curves of the embankment, whether concave or convex to the river, present surfaces along which the water will flow in unbroken sweeps, although these may not be in conformity to the *natural* form of its channel. Beside the embankment, the form of the channel should be made with easy sweeps, by taking away projections of the bank on one side, and filling up deep bays on the other.

5746. The line of the embankment should be marked off with pins, and the turf raised along the breadth of ground to be occupied by the embankment. In raising the turf, that intended to cover the *face* of the embankment next the stream should be at least 1 foot square, unbroken, and tough; and if the river bank does not afford turf of this description, it must be obtained elsewhere, and brought to the spot. The turf to build the face-wall may be of any description possessing tenacity at all. The turf for the sloping-bank should be cut with bevelled edges, so that each turf may overlap two lower turfs with two of its edges—the one edge, the lowest, overlapping down the slope of the bank, the other with the flow of the river. The proper and relative position of the turfs being settled, the embankment should begin to be constructed at the lowest point of the stream, and carried up its course.

5747. I shall suppose that the turf-wall *a b*, fig. 485, shall be four feet in height, next the field; then a breadth of 6 feet from *b* to *c* being the base of the slope of the embankment, may give sufficient stability to the structure, and slope to the face. The line *b c*, however, will vary with the nature of the ground on the river bank. In a steep part, less slope may suffice; and in a sudden and narrow hollow it may be necessary to fill it up altogether, to make the bank uniformly even; and the slope may have to be built up

with a gentle acclivity, from the very edge of the water. 5748. The first operation in the actual construction of the embankment is build-

Fig. 485.



AN EMBANKMENT AND FACE DRY-STONE DYKE AGAINST A RIVULET.

ing the turf-wall *a b*, the sods of which are laid with the grassy face downwards, on the same principle as breaking band in masonry. As the wall proceeds, earth is taken from the field in spadefuls to pack behind it, and to fill up the contents of the embankment included within *a b c*. This earth should be free of stones, and, if disposed to rise in lumps, should be chopped small with the spade before it is thrown into the space, and then compressed firmly with a wooden beater. After a sufficient quantity of earth has been placed behind the turf wall, the turfs of the slope *c a* are begun to be laid at the lowest point *c*, where the first turf *d*, with the grass-side upmost, is made to grip under and abut against the sward *e* of the river bank, by a notch cut out of the latter with the spade—the object of the notch being to fix the edge of the turf under the sward, to prevent the water getting hold of it and carrying it away. Another turf *f* is made to overlap with its lower edge the upper edge of the turf *d*, just laid; and the earth is brought behind it with a trowel, or with the hand, to the inclination of the slope *c a*. In like manner, the turfs *g, h*, and *i* are laid one after the other, till the top of the turf-wall *b a*, is reached by the top of the slope *c a*, where a thick turf *k*, with the grass upmost, is made to cover the top of the wall and of the slope at the same time. When the turfs are cut square, and of the same size, which they should scrupulously be, they are quickly and evenly laid. The whole of the turfs are then beaten firmly down with the back

of the spade. It will be seen, from this description, that the building of the turf-wall *a b* should be in advance of the laying of the turf upon the slope *c a*.

5749. In conjunction with the turf-work, the building of the stone-dyke, *l m*, may proceed and finish the whole embankment at once. The dyke required here is a *single-faced* one, with suitable covers and a strong cope; and it will serve greatly to strengthen the embankment against the pressure of the water.

5750. The cost of making an embankment 4 feet high in the wall, 6 feet broad in the base, and casting the turf for it, the materials being all at hand, is 1s. 5d. per rood of 6 yards. If the turf has to be brought from a distance, the trouble of its carriage devolves upon yourself. The cost of building the face-dyke 5 quarters high is 8s. per rood of 30 lineal yards, and the quarrying and carriage of the stones will each be as much, or rather more—perhaps 9s. per rood.

5751. An embankment for this purpose should be constructed as early in the season as possible, to give the turf time to grow together before the earliest flood in winter. Should the summer prove very dry, the turf may become brown, when water should occasionally be thrown upon it with a scoop from the rivulet; and in any sort of season it is possible that a turf here and there will die, when it should be immediately removed and a fresh one sub-

stituted in its place. Until the turfing becomes converted into a thick and tough sward, it should be frequently inspected, and every gap in it plugged up, whether occasioned by accident, such as the feet of cattle trespassing from the opposite side, or the burrowing of animals, such as rabbits or water-rats. By the succeeding season the grass will have grown luxuriantly upon the slope, when it may be mown early in summer, to give it time to grow thicker before winter. After this period the earth will have become quite firm, and the embankment will require nothing more than a general supervision every year.

5752. Should the embankment cut off the river as a means of watering the stock in the fields, a pool should be formed at the lowest part of each field, the bottom of which should be dug below the ordinary level of the water in the river; and should the subsoil consist of gravel, the water will ooze through it from the river into the pond; but should it be of impervious clay, a conduit formed by an iron pipe should be laid from the water in the river to the pool. In case the river overflow to a height above the surface of the field in winter, the end of the pipe next the pool should be plugged up for the winter, after the stock have retired from the field; and when the field is not in grass, the plug should remain undisturbed in the pipe.

5753. The sort of embankment I have been describing is only applicable to small rivulets which have little water in them in summer; but in case of considerable rivers, a much more substantial embankment will be required, to parry off their inundating efforts at times. Such an embankment is described, in general terms, in the following words by a competent writer:—“When rivers which pass through low grounds are to be embanked or confined, that the floods they bring down may not inundate the adjoining lands, care must be taken to make the banks sufficiently strong, as, the force increasing as the embankment is raised—in consequence of the stream not being able to expand itself in proportion to the increase of water—the more it is allowed to spread, the less occasion is there for strong barriers. The slope of such embankments should not be less than twice their height; and three times are necessary when the rivers they confine are affected by the tide, or subject to the force of the sea-wave; the thickness at top should not be less than 5 or 6 feet, and the

inside slope should be one perpendicular to one of base: for sea-banks, where the waves do not rise higher than 4 feet, the thickness at the top may be 6 feet, the slope on the land-side $1\frac{1}{2}$ foot for every 1 foot in height, and on the sea-side 4 feet to 1 foot in height. The slope on the land side must vary with the height of the waves, and should be increased to $2\frac{1}{2}$ base to 1 foot of perpendicular height: the slope on the water-side should be still more, in proportion to the rise of tide: for every increase of a foot in height the slope must be greater, so that when the waves amount to 10 feet in height on the water-side, it should be 10 feet for every foot in height. When the earth with which the embankments are formed is of a gravelly or loose nature, it is requisite to carry up in the middle a wall of clay, or some impervious material; the system of puddling is now generally adopted, by which the percolation of the waters is prevented.” In consequence of the unprecedented floods in August 1829, the Isla, in Forfarshire, was embanked out after a long period of annoyance.

5754. “Within walls of embankments, provision should always be made to let off the land-waters. . . . The simplest form is a clapper or valve, hung at the top, and falling over the opening of the pipe or trunk of discharge, which is kept closed as the tidal water rises and presses against it. Sluices are at other times used, which slide up and down in the frame; and the ordinary lock-gate either made to revolve on a pivot, or to shut like folding-doors against a fixed frame. The passage through the wall consists of either a mass of masonry or a pipe of cast-iron; for culverts the latter is generally preferred.*

ON THE CONSTRUCTION OF FIELD-GATES.

5755. Immediately in connection with enclosures and fences are field-gates; and their proper construction is an important element in their agreeable use, and in their durability, irrespective of the material of which they may be constructed.

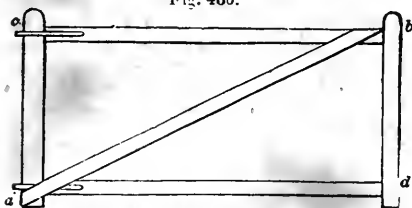
5756. A field-gate may be described as a rectangular frame, and a simple rectangular frame is the most liable to change of any connected structure of framework. On the other hand, the triangle is the most immutable of any form, and as long as the materials remain, it will never change. To have the most immutable field-gate it ought, therefore, to have the triangular form; but in practice, a gate in the form of a triangle would be most unserviceable; though a combination of

* Cressy's *Encyclopædia of Civil Engineering*, p. 1558.

triangles will produce the requisite figure for a serviceable gate.

5757. If we take the most serviceable form for a gate, the rectangular, and apply a bar to it, in the position of a diagonal of the parallelogram, we immediately convert the original rectangle into two triangles, applied to each other by their hypotenuse. Such a combination gives us the true elements of a properly constructed field-gate, every other part being subordinate, and only adapted to the practical purposes of the gate as a defence or an ornament. Thus, then, the essentials of a field-gate, whether of wood or of iron, are, a rectangular frame, consisting of the heel and head posts, and a top and bottom rail; which four parts, properly connected at the angles, are rendered of an unchangeable figure, by the application of one or more diagonal bars, which in no case ought to be applied short of the whole length, between any two of the opposite angles. Fig. 486 represents such a com-

Fig. 486.



A RECTANGULAR FRAME WITH DIAGONAL STRUT.

bination, where ac is the heel post, bd the head-post, and cb and ad the top and bottom rails of the rectangular frame of a field-gate; and ab is the diagonal, which converts the rectangle $acbd$ into two triangles acb and bda .

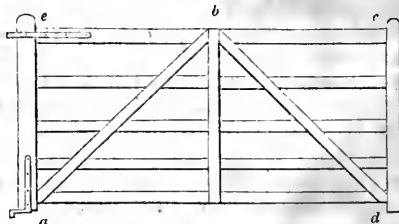
5758. In field-gates constituted entirely of wood, the diagonal should invariably be applied as a strut, to rise from the foot of the heel at a , and terminate at the top of the head post at b . Placed in this position, the diagonal ab supports the swinging end of the gate bd , by its resistance to compression; which it is well adapted to perform by the area of its cross section being considerable, and hence capable of resisting lateral flexure.

5759. But a field-gate is liable from

various causes to be forced up at the head-post bd , however well the diagonal is adapted to prevent the upper rail from being depressed, by any undue weight, exerted upon its end at b . The advantages of a tie are the converse of a strut. If a tie, therefore, is placed from c to the opposite angle d , crossing the strut ab in its centre—and an iron bar makes a perfect tie, the cohesion of which is such that a very small sectional area is sufficient for the purpose—the two antagonistic forces of the wooden strut and the iron tie, acting each in its own sphere, preserve within the whole structure the most perfect equilibrium.

5760. A very common form of field-gate to be seen in this country is shown in fig. 487; and, applying the principles to

Fig. 487.

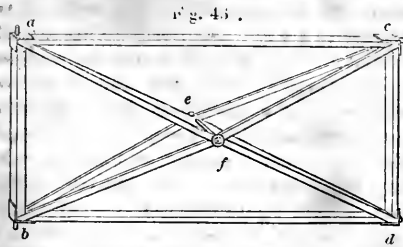


A COMMON FIELD-GATE.

it which we have been considering, we shall find it defective in several most essential particulars. It has a strut ab , but instead of extending across the entire diagonal to c , it stops short at the centre of the gate at b . The part of the top, bc , is liable to be broken off, by any undue force being exerted upon it at c , when it is converted into a lever, whose fulcrum is supported at b by the end of the strut ab . It has also a tie bd ; which is not only made of a wooden rail, but it does not extend across the rectangle to e , and in no part does it cross the strut ab , so as to act with it in maintaining an equilibrium of forces. The consequence in practice is, that this form of gate is very frequently fractured at the head-post cd , and falls to the ground at d . The wood of a gate such as this costs, in larch, 9s. or 10s., and the crook and band, a and e , 10s. more.

5761. The principle of trussing has been successfully introduced into the wooden

field-gate by Sir John Orde of Kilmory in Argyleshire. Fig. 488 shows the rect-



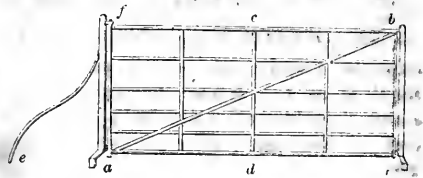
THE KILMORY WOODEN TRUSSED FIELD-GATE.

angular form trussed, so as to make a compact firm structure. The heel-post ab , the head-post cd , and the upper and lower rails ac and bd , form the rectangular frame. The truss consists of 4 bars of wood, ae , be , ce , and ed , each of which abuts into an angle of the rectangle, and all meet at the centre of the gate e ; where, each bar being longer than the half of a diagonal of the rectangle ad , they become elevated in the form of a pavilion roof. A similar truss is formed for the other face of the gate, whose apex is at f . Through the points e and f , the apexes of the trusses, passes the iron bolt ef , the head of which holds the bars at f ; and a screw and nut upon a plate hold those at e ; and when the screw is tightened, the trusses are brought nearer together in the centre, and their ends abut with great force against the angles of the rectangular frame at bac and d . To resist this pressure, it is necessary to connect the posts and rails with an iron clamp at each angle of the frame. I believe that this construction of gate will admit the frame neither to bend nor twist, and it will bear any pressure of stock against its sides; but its peculiar form is attended, in my opinion, with a practical inconvenience. The trusses rising on each side of the gate $9\frac{3}{4}$ inches above the plane of the frame, the projecting parts at e and f present an easy and ready hold for the foot of a colt, should he disposed to amuse himself about the gate—a recreation which young horses are apt to indulge in; and the same projection will likely graze against the sides of the cattle, and lay hold of the harness of the horses when passing through the gate. I am therefore doubtful of its utility as a common field-gate. The interior of the frame can be filled up with any light material, as wire or spars of wood. When

fitted up with wooden spars, the frame costs 13s. 6d., and the posts suited for it 13s. 6d. more—together 27s.

5762. But now that iron is forged of sizes suitable for the construction of field-gates, the probability is that, ere long, gates of iron will altogether supersede those of wood. Fig. 489 gives a simple form of

Fig. 489.



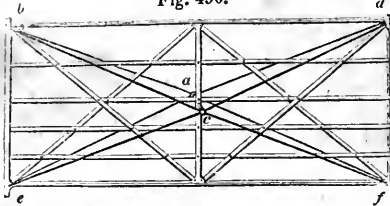
AN IRON FIELD-GATE WITH IRON POSTS AND STAY.

an iron field-gate. It consists of six rails, so arranged as to keep in lambs in the lower part of it. It is both light and strong. The fore-style bg is prevented dropping by the diagonal bar, ab , which, on being applied with its flat side, is riveted to each of the rails; and the twisting is counteracted by the top and bottom rails, fb and ag being welded flat-ways to the fore and hind styles with strong solid knees. The upright bars, as cd , retain each of the rails in its proper place. The gate frame is 9 feet long, and 3 feet 9 inches in height. The gate can be hung upon wooden posts; but the iron posts, as shown in the figure, correspond better with the appearance of the gate. They are made of malleable iron, and are fastened into large stones with double bats; and the hanging-post fa is additionally supported by a stay e . The cost of this gate is 30s., and the posts 20s. more—together 50s.—which price completes all the necessary bolts and nuts for fixing them to the stone blocks, and hanging the gate on the posts. This form of gate would probably be strengthened by the introduction of a tie stretching from f to g across the centre of the diagonal ab .

5763. The same species of iron gate is made on the tension principle, as seen in fig. 490, where the other parts than the tension are different from those in fig. 489, in not having diagonals as ab . In fig. 490 strong iron tension wires pass through the cast-iron blocks a and c , connected together with an iron collar, in

the centre of the frame. These wires are fastened by heads to the upper bar and

Fig. 490.

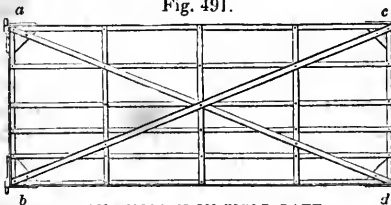


AN IRON FIELD-GATE ON THE TENSION PRINCIPLE. stiles at *b* and *d*, and drawn as tight as required at the lower bar and stiles at *e* and *f*, by means of nut and screw. The cost of this gate, without the posts, is 25s.

5764. It will be observed that the central apparatus of this gate is similar in appearance to that of the Kilmory wooden gate in fig. 488; but their mode of action is the opposite, though the effects produced are similar. In fig. 490, the wires from *a* and *c* act as ties, drawing the posts and rails towards them from the angles, and thereby giving to the entire framing a rigid structure. In fig. 488, the wooden struts from *e* and *f*, as centres, push the posts and rails outwards at the angles against the clamps, thereby also giving the framing a rigid structure.

5765. Angle iron, so extensively used in boiler-making, ship-building, and other purposes, has also been used in the construction of field-gates. Fig. 491 repre-

Fig. 491.



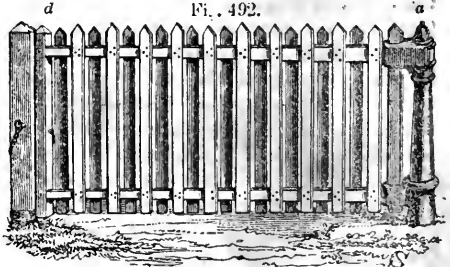
AN ANGLE IRON FIELD-GATE.

sents a gate made of it. The external frame is composed of 4 bars of angle iron; and, to give security to the joinings at the 4 angles of the trusses, the ends of the bars are riveted upon cast-iron corner-plates; those of the heel-post *a b* being formed of strong projecting pivots, by which the gate is hinged. The diagonal *b c* is contrary to the general rule, for it is apparently a strut; but being of angle iron, it

possesses the stiffness of wood to resist lateral strains. To render the bracing complete, the antagonist diagonal *a d* is applied as a tie. The upright bars are all riveted to the horizontal ones, as well as to the diagonals, so that the frame is rendered unchangeable in figure by any force that might be applied to the head post *c d*. Any number of interior bars may be added to suit the objects of the gate. The figure exhibits the arrangement adapted to retain lambs, which are the smallest-sized stock confined in fields. The cost of this gate, without posts, is 25s. The frame is 9 feet long, and 3 feet 9 inches in height.

5766. I have seen a gate constructed by Mr Charles Miles, architect, London, which seems to me well adapted for fields. It consists of both iron and wood. It has a strong cast-iron heel-post, *a*, fig. 492;

Fig. 492.



MILES' WOODEN FIELD-GATE WITH IRON HEEL-POST.

which is round, tapering to the top, and is batted into a large stone in the ground. At *a* is a collar of iron embracing and revolving round upon a projecting head encircling the post. To one side of this collar is attached a socket of considerable depth, and of a form to receive into it the upper rail of the gate, which, when properly seated, the socket prevents from drooping at the head *d*. The under rail style is in every respect fitted up in the same manner as the upper one. The head style *d* is light, and completes the framing. The filling-up of the frame is left to choice, either in iron or wood. In the figure the filling-up consists of light wooden spars, nailed on alternately upon both sides of the upper and lower bars. Were a wooden strut introduced into the frame from the bottom rail to the opposite angle at *d*, the gate would be much strengthened, though the deep hold of the sockets makes the rails much more rigid than might be expected. The

receiving post is made of wood, fitted into an iron socket, which is batted into a stone. The cost of this gate without the receiving-post is £1, 17s. 6d., the cost of that post being 7s. 6d.

5767. When speaking of the repairs of fences in summer, a substantial method of sinking a wooden gate-post is given in fig. 295, and (3575.) Another method is in digging a hole $2\frac{1}{2}$ feet square, and of the same depth; and the post being set into it, the pit is filled with rubble masonry in mortar, packed firmly, and grouted round the post. This is, no doubt, a very effectual mode of fastening gate-posts—a matter not so well attended to on a farm as it ought to be; and the lime may tend to preserve the wood under ground a longer time than it would be without it; but it is expensive, and when the post has to be renewed, the masonry will have to be removed, as no new post can again be fixed so firmly in the pit, as when both were put in together. The tops of the posts should always be semi-spherical, or pyramidal, to prevent the lodgment of water upon them. The portion of the post under ground should be charred, and afterwards well saturated with coal-tar, by a similar process to that described in (5728.)

5768. There is no better mode of hanging a field-gate than by crook-and-band hinges at the upper rail, and a heel-crook at the bottom of the heel-post. Both the band-hinge and the heel-crook ought to be double-tailed, to embrace both sides of the heel-post and of the upper rail. The upper-crook keeps the gate close to the upper part of the hanging-post, while the heel crook, resting on and working in a hole made in a hard stone, supports the entire weight of the gate. A gate-post of whatever kind, which has to support the entire weight of a gate, requires to be very securely fixed into the ground; but when the gate is supported by a heel-crook, the post may be of more slender form.

5769. The simplest mode of fastening field-gates to the head-posts is to hook on a small linked chain from the stile head of the gate to a hook in the receiving-post. No animal is able to unloosen this simple sort of fastening; but horses soon learn to unfasten almost every other sort.

5770. Field-gates ought to be painted before being put to use, and they ought to receive a new coat every year, as without it they will rot in a comparatively short period of time. Iron gates must of necessity be painted, to keep them from rusting. Coal tar does not look well as a paint, and is apt to blacken the hands and clothes after exposure for a time to the air. Many compositions are presented to the public notice as suitable for painting outside work, but there is nothing better than good white lead and oil. Field-gates painted white have a lively appearance amongst the dark green foliage of thorn hedges.

5771. I consider wire an unsuitable material for the construction of field-gates, being too flimsy to bear the constant use of opening and shutting, and the pressure of animals confined in, or going out of and into fields.

5772. Large stones set on end form appropriate gate-posts, in connection with stone dykes; but built pillars for supporting gates are generally very short-lived on a farm.

5773. In the Isle of Man, although its agriculturists cannot boast more than ourselves of the perfection of their gates, nature has supplied them with an admirable material for gate-posts. The transition slate with which the island abounds is found in one locality, Spanish-head, of a nature that serves all the purposes of beams and planks of wood; and of this many, indeed most, of the gate-posts are formed. In Scotland we have now in abundance a material equally suitable for the same purpose, in the Caithness pavement, which is now applied for gate-pillars, and for which no material can surpass it. They are built into the ground in the same manner as wooden posts, and look very much like a plank of wood, but possessing strength, and especially durability, far beyond wood. The crook-hinges are either fixed into them by passing through them, as bolts through a jumper-hole, or they may be put on in the form of a hoop, and secured with wedges.

5774. It would be desirable to have a substance which would preserve wooden gate-posts as many years as a lease generally runs. A process is recommended by Messrs Hutin and Boutigny as fit for such a purpose. The process of the decay of wood is thus stated by them: "Woods are destroyed by the incessant action of moisture and of the oxygen of the atmosphere, which principles penetrate to the core of the wood by absorption and infiltration. By their presence in the wood, and their con-

tinned action on the elementary fibrine, they give rise to a kind of slow spontaneous combustion, called by Liebig *eremacausis*. This penetration of destructive elements goes on exclusively by the ends of the wood, and in the natural channel of the flow of the sap. Hence, if we prevent the destructive action of these causes upon the wood, we can preserve it indefinitely; and by hermetically closing the absorbing ends of the wood, we accomplish the end in view. For a considerable time we have thought that woods could be best preserved by coatings of oily or resinous matters. This is certainly the most rational mode of procedure; and if complete success has not been hitherto attained, this is to be attributed rather to the improper methods of applying them. Our method consists in drying the ends of the woods; neutralising their power of absorbing moisture by slightly charring them; and hermetically sealing them by means of a substance which penetrates between the fibres, incorporating itself with them, and preventing the destructive action of the element in which they are placed. The plan of procedure is simple, expeditious, of small expense, and capable of being practised by any one, requiring no particular apparatus nor workmen. It is as follows:—

Plunge the ends of the wood to be preserved in any carburet of hydrogen, which rapidly penetrates the fibres. Set fire to it, and at the moment when the flame is extinguished, plunge the wood into a warm mixture of black pitch, tar, and gum lac. This cement penetrates some way between the fibres, and forms at each end of the wood a kind of hermetic sealing which remains unchanged. The wood is afterwards tarred all over in the usual way."

ON THE DRAINING OF LAND.

5775. The buildings having been provided for, and the surface of the ground laid out in suitable enclosures, and fenced with thorn hedges and stone dykes, and furnished with gates, our attention should now be turned to the improvement of the soil constituting the surface, by the various processes of draining, trench and subsoil ploughing, and liming. The primary process of all these is draining.

5776. When draining is about to be conducted on so large a scale as the drying of a whole farm, it might be deemed best to drain the ground before enclosing it, with the view of conducting the operation on a corresponding scale to the extent of surface to be drained. Two well-founded objections can be stated against the adoption of so general a plan— one is, that it would impose the necessity of running hedges across drains, by which

they would be certainly injured, by the roots of the hedges finding their way into them, and rendering them useless; and the other objection is, that long runs of drains are to be avoided in every system of farm drainage. It therefore appears that the safety of the drains demand that the land should first be inclosed, and then the drainage of each field should be conducted by itself, and that as many fields as the figure of the ground admits of should be made to discharge their waters into the same outlet. Besides securing the general safety of the drains, the drainage of each field is attended with the advantage of laying off and executing the drains in it, in accordance with the peculiar nature of its subsoil and the form of its surface; whereas none of these necessary particulars would be sufficiently attended to were a general system of draining adopted.

5777. It is possible that the entire surface of the farm may not require draining—a portion of the soil may rest on gravel or other porous material. Where such a case occurs, the expense will be reduced to that extent; and yet if the open subsoil, however dry in summer, becomes damp in winter, by water coming then from a distance, it will require to be drained as well as the most impervious, though at less cost.

5778. It is no difficult matter to determine whether or not land requires draining. By the experienced eye, the particular parts of a field most affected by superfluous water are easily detected: the peculiar state of the crop the field bears at the time indicates them; such as want of vigour in growth, a sickly hue of colour, and none of the parts sufficiently developed, which are all strong indications of the presence of water—and these are more evidently exhibited by grain and green crops than by the sown grasses; and also by *old* pasture, which bears coarse, hard, uninviting herbage. The soil that indicates such a condition of vegetation always feels unelastic under the foot.

5779. Moist land may also be easily detected by the inexperienced eye. In March, after being ploughed, when the air is dry and keen, large belts of dark-coloured soil

may be observed near the top of acclivities, whilst the rest of the field *seems* drier, of a light-brown colour; or marked with only small dark spots here and there; or only the flat and hollow parts are covered with dark soil. All these palpable hints of water lurking below cannot be mistaken; although they may disappear, or are much contracted, in dry, and much extended in rainy weather. When they disappear on the approach of summer, it is erroneously concluded that they can do no harm to cultivated plants, and the land *requires no draining*; whereas it is the water *remaining in the soil all winter* that injures the crops in summer. Superficial symptoms of dryness may not indicate the true state of the subsoil, for that water does lurk in it to a very great extent in this country, and will continue so to do, until vents are made for its egress, is an established truth—so much so that even naturally dry soil around wet becomes injured by imbibing the stagnant water from it. The mere *wetness*, which disappears partially in spring, and altogether in summer, would not injure growing crops, as it would all be absorbed, and more, in the wants of active vegetation; but when it remains stagnant, and occupies the pores of the soil and subsoil all winter, it renders them so very damp, that most of the summer's heat is required to evaporate it. The heat of the summer is thus engaged in evaporating the moisture, and thereby producing a coldness in the atmosphere, instead of nourishing the growth of the crops, which it would otherwise certainly do. Even after the soil and subsoil have been drained, the winter rain passing through them takes some of their heat, and conveys it away in the drains; but though such an abstraction makes them somewhat colder, it cannot render them either wet or son; and having now free access to the air, they necessarily assume its temperature. In these altered circumstances, the heat of spring and summer have only to push forward the growth of the crops to fill them fully, to make them of fine quality, and to bring them to maturity.

5780. Where the symptoms of wetness are obvious to the senses in summer, there is no doubt of the land requiring draining. An obvious excess of water may injure

useful plants, since the excess is usually indicated by the presence, in number and luxuriance, of sub-aquatic plants, as rushes, *Juncus acutiflorus* and *J. effusus*, which only flourish where water is too abundant for other kinds of plants. In what manner the injury arises is not apparent; although observation has shown that *stagnant* water, whether upon or under the surface, does injure the growth of all useful plants. It perhaps prevents, or at least checks, all useful perspiration or circulation, and by affecting the chemical state of substances which largely supply the food of plants. Be the cause of the injury what it may, experience assures us that draining prevents all its bad effects. The deficiency of crops frequently attributed to unskilful husbandry, on apparently dry land, arises, in my opinion, from the baleful influence of *concealed* stagnant water; and want of skill is here shown, not so much in the mismanagement of the arable culture, as in the neglect to remove the concealed moisture; for, let the culture be ever so skilfully conducted, it will never produce so great and good crops from damp as from naturally dry or thoroughly drained land. A conviction has been forced upon me by long and extensive observation of the state of the soil over a great portion of the kingdom,—that the neglect of draining is the *true cause of most of the bad farming to be seen*; and that a *single farm does not exist*, not already thoroughly drained, which would not be *much the better for draining*.

5781. We cannot inquire too minutely into the extensive injury sustained by the soil, and its products, by the *stagnation of rain water upon an impervious subsoil*. Most of the soil of Scotland consists of loam, of different consistence, resting upon tenacious clay, of unequal depth. Where the soil is shallowest, it is injured by the stagnant water remaining constantly beneath it; and where deepest, it is injured by chilly exhalations arising from the water below. The direct injury done to soil by stagnant water, may be estimated by these effects. Manure, whether putrescent or caustic, imparts no fertility to it; the plough, the harrow, and even the roller, cannot pulverise it into fine mould. The new grass contains little nourishment for live stock; and in old, the finer sorts dis-

appear, and are succeeded by coarse sub-aquatic plants. The stock never receive a hearty meal of grass, hay, or straw, being always hungry and dissatisfied, and of course in low condition. Trees acquire a hard bark and stiffened branches, and become a prey to parasitic plants. The roads are constantly soft, and apt to become rutted; whilst ditches and furrows are either plashy, or, like a wrung sponge, ready to absorb water. The air always feels damp and chilly, and, from early autumn to late in spring, the hoar-frost meets the face like a damp cloth. In winter the slightest frost encrusts every furrow with ice—not strong enough to bear one's weight, but just weak enough to give way to every step—while snow lies long lurking in shady corners and crevices. In summer, mosquitoes, green-flies, midges, gnats, and gadflies torment the cattle and the ploughman and his horses, from morning to night. In autumn, the sheep get scalded heads, and are eaten into by the maggots of the green and carrion flies, during hot blinks of sunshine. These are no exaggerated statements, but such as I have observed in numerous situations—in hill, valley, and plain; and wherever these phenomena occur, to a sensible degree, it may safely be concluded that stagnant water lurks beneath the soil. Entertaining this opinion, and knowing these facts, it is not surprising that I urge the practice of draining with much earnestness.

5782. Having no doubt of the places which require draining, the process should be gone about in a systematic way. In a newly made out farm, the power to commence the draining in any given place rests with the farmer; but on a farm in an ordinary state, fields can only be drained at a certain period of the rotation. The most convenient, cleanly, and easy condition for the land to be in for draining is when it is in grass; and when it is determined to drain land while in grass, the *season* for opening the drains is thereby determined. It would not be prudent to sacrifice the entire pasturage of summer, and no stock should be allowed to roam in a field while being drained—both on account of injuring themselves by slipping into, and of breaking down the edges, or fracturing the tiles of the drains—so the grass should be consumed; but, that the

draining may commence soon in autumn, the grass should be eaten down by that time. Whether or not more than one set of men are engaged in cutting the drains, they should all be employed in the same field together, as loss of time is incurred in driving materials to different fields; whereas, with concentrated work, one field after another becomes drained and fit for being ploughed: and such a course permits the eating down of the grass regularly, field by field, as the draining proceeds, so as to sacrifice as little of the grass as possible. These precautions being taken, and the materials laid down, the operations may be carried on through the winter, and as far into spring as to give time to plough the lea for the seed.

5783. When the grass field is not intended to be ploughed—such as a small field in front of the farm-house, or the lawn around a mansion-house—the turf should be neatly re-laid over the drains, and somewhat above the level of the ground, to allow the earth to subside, and a heavy roller made to press it down. The turf should be re-laid and rolled in fresh weather—or even in damp or wet weather, provided the grass is dry when rolled.

5784. The divisions to be occupied by oats after lea should be drained every year, until the whole farm is dried; but a greater extent of land may be drained in any year, if desired—such as a portion of the fallow-break if bare-fallowed for wheat, or prepared for turnips. Indeed, some farmers prefer draining in summer to any other season, as the land can then be carted on with freedom; the days are long, and a good day's work done—whilst every other sort of work is in a state of cessation. These are good reasons for summer draining: but unless the entire fallow-break is bare-fallowed, so large an extent of fallow-land as of lea cannot be drained; and if so large an extent cannot, the operation will necessarily occupy more years than are members in the rotation. No time will be found in spring to drain the part of the fallow-break to be occupied by potatoes, and certainly not the whole of the part intended for turnips; and it would be placing the sowing the wheat seed in autumn in jeopardy to drain after the

potatoes and turnips have been removed from the ground, besides the slovenliness of poaching the ground after it had been dunged and prepared to serve a whole rotation. No advantage would thus be derived by draining in spring and autumn instead of in summer. A few short-drains in a particularly wet spot may be executed after the potatoes have been lifted in autumn, and the turnips eaten off in spring, but to no further extent. The lea ground, therefore, presents the largest extent of surface for drainage, with the least interference with growing crops and prepared ground; and the space may be enlarged by draining as much of the fallow-break as is devoted to fallow-wheat.

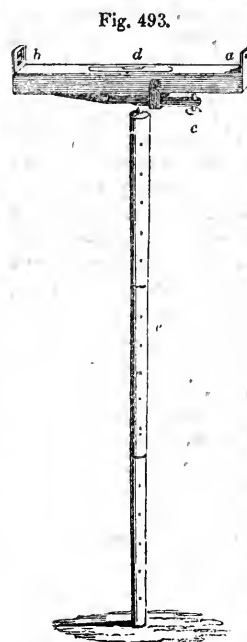
5785. The fields should be drained in succession, and the one to commence with should occupy the lowest part of the farm. As drains, however, are most conveniently made when fields are in grass, it may happen that the field which comes next in succession for drainage is not the lowest one in regard to position. Notwithstanding, it should be selected for commencing the drainage; and care should be taken not to let the water from it make the field below it wetter.

5786. It may seem an indiscriminate advice to recommend the draining of every field, as it is possible that a part of some of them may not require it; but it is scarcely probable that no part of any field will not require it. Be this as it may, a system of thorough drainage requires every field to be examined in regard to its *state of wetness throughout the year*. Land which retains water in winter is in a bad state, though it should be burnt up in summer; because the burning in fact requires draining to cure it. Lands burn when naturally light, thin, and on retentive subsoil. Being thin, they are easily saturated with rain in winter; and being light, the water in them is soon evaporated in summer; and when drought continues, the crop is soon burnt up. Now, draining is the best preventive against all these effects, because drains serve as reservoirs for moisture to be taken up to the plants by capillary attraction through the dry soil in summer, thereby counteracting the effects of drought; and they act as ducts for the conveyance of superfluous water in winter,

thereby counteracting the effects of cold and wet. I have myself thus cured burning land by draining.

5787. Should the farm be pretty level, it matters not at what side the draining commences; but when it has a decided inclination one way, the lowest part should be first drained, to afford the water from the upper parts at all times an outlet; and when the inclination occurs in more than one direction, each plane of inclination should have a system of drains for itself, commencing at the lowest point of each.

5788. In level ground it may not be easy to determine the fall by the eye; and as it is of the utmost importance to have a good outfall for the drained water, the fall should be ascertained by means of a spirit-level. A *spirit-level* of the form of fig. 493 I have found a very convenient in-



THE SPIRIT-LEVEL SET FOR OBSERVATION.

strument for ascertaining the fall in apparently level pieces of ground, and generally for taking the falls in fields. When in use, it is placed in a frame of brass, a projecting part of which operates as a spring to adjust the instrument by pressure to the level position *d*, on the large-headed brass screw *c* being turned. A perpendicular stud in the under part of the brass framing is pushed firmly into a gimlet-hole in the top of the sharp-pointed supporting rod *e*, which is inserted into the ground whence the level is desired to be ascertained. Two eye-sights, *a* and *b*, surmount the level, *a* being a small hole for the eye to look through, and *b* a large square opening, furnished with two hair wires crossing at the centre. Such a

spirit-level costs 15s., and is made by Adie & Son, Opticians, in Edinburgh. When not in use, the brass frame is placed between the eye-sights over the spirit-tube to protect it, and a movable cover of wood, not shown in the figure, is placed over the whole. The instrument is 8 inches in length, $1\frac{3}{4}$ in thickness, and 1 inch in breadth, and so light that it can easily be carried in the pocket, whilst the rod may be used as a walking cane.

5789. When it is desired to ascertain the fall in a flat piece of ground to be drained, plant the level on its stick about the middle of the piece of ground, and after placing the eye-sights of the level in the direction in which the fall is desired to be ascertained, adjust the instrument, by turning the screw *c*, until the air-bubble *d* indicates the level position. An assistant holds up a rod at the end of the ground in that direction, and marks the point upon the rod signaled by the person using the spirit-level. He then goes with the rod to the end of the ground in the opposite direction; and on the level being adjusted and the observation taken, he marks that point also upon the rod. Should both marks coincide, the two extremes of the piece of ground are on a level; and should those points be of the same height from the ground as the eye-sights of the spirit-level are, the entire piece of ground may be regarded as level. Whatever difference may be indicated between the points, the subtraction of the less from the greater height gives the fall towards the point of the greatest height. For example, if at the first station the mark on the rod measures 3 feet 9 inches above the ground, and at the second 4 feet 8 inches, the difference—namely, 11 inches—gives 11 inches as the fall in the ground from the first to the second station. Take a more difficult case. Suppose that a knoll in the middle of a field renders it difficult to see the direction of the general fall of the ground, which is flat. Let a point be chosen to place the level, from which the field on both sides of the knoll may be seen at once, and then observe from this point one or more parts of the ground—first on one side of the knoll and then on the other—and the differences between

these sides will show which side is lowest, according to the above rule, and by which the general drainage of the field will have to be effected. A very little practice with the instrument will show its use in every case of inequality of ground. In ascertaining the *relative* heights of distant points of a field, the height of the instrument standing on the rod above the ground is not taken into account; but on ascertaining the *absolute* height of the spot upon which the instrument stands, above or below that of any other spot of the field, the height of the instrument is taken into account.

5790. There should be a decided fall from the outlet of the drain, whether effected by natural or artificial means. Mr Cressy states that, in the case of drains, it should not be less than 8 feet in the mile, or 1 foot in 220 yards. In large deep rivers the fall is sufficient at 1 foot in the mile, and in small rivers 2 feet.* The open ditch which receives the outlet water should be kept scoured deep enough for a considerable distance; and it is better to deepen it at the lower end than to increase its width, when the ground is level. A frequent charge of neglect against farmers, is allowing open ditches almost to fill up before they are scoured out; and the ready excuse for the neglect is, that scouring ditches to any extent incurs considerable labour and expense; and no doubt it does, when they are allowed to fill up. But were ditches scoured as they require it—and every year, if necessary for the welfare of stock, fences, and drains—little expense would be incurred at one time. It would be better to incur the expense of converting an open ditch into a covered drain at once, than to neglect the scouring of it when necessary. Should the fall from the outlet towards a river be too small, a covered drain should be carried parallel as far down by the side of the river as to secure a sufficient fall. Rather incur the expense of carrying the drain *under* a mill-course, mill-dam, or rivulet, by means of masonry or a cast-iron pipe, than allow back-water to gorge a drain.

5791. In cold countries in winter, such as Russia, Sweden, and Canada, where the frost sometimes penetrates into the ground

* Cressy's *Encyclopædia of Civil Engineering*, p. 1557.

to the depth of 18 inches, a proper outlet to protect the water from frost, as it issues from the drains, constitutes an essential element in every system of drainage. It is evident that shallow drains of 18 or 20 inches, such as are too common in England, will not answer in those countries; the water would freeze in them and derange their structure, and tiles would be burst into pieces. It is equally evident, that if the water were frozen as it issued at the outlets of drains, the ice would cause the water to stand back in them in a stagnant state; and although the depth of the drains should have placed the water beyond the reach of frost, the upper part of the ground would draw up the water from below, by means of the capillary force, and, there becoming frozen, materially injure the surface soil. The only practicable way I can therefore see of retaining the water in a liquid state in such climates, as it issues from the outlet, is to place the outlet at such a depth as to be beyond the reach of frost, and to convey the water in a deep and long covered drain. Much foresight is thus required, and much expense must be incurred in making drains in countries where frost penetrates the ground to a great depth.

5792. Besides the fall for the outlet, the fall in the field to be drained requires consideration. In very level ground the natural fall may not be sufficient to carry away the water quick enough; and in such a situation no way exists of increasing the fall but by artificial means—that is, by causing a greater fall than on the surface, by cutting the drains deeper at their lower ends than at the upper. Whatever depth of drain, therefore, should be determined on for the whole field, the lower parts of the drains should be cut deeper and the upper shallower than the determined depth; and the fall should be brought up to 1 foot in 220 yards, if practicable. In level ground the force of the water should be increased by keeping it in narrower channels; and its depth will thereby increase as it flows nearer to the outlet of its own drain, wherever that is. Level ground will absorb more of the rain than inclined, along which, part of the rain always flows away above ground, and never enters the drains. The object in producing a fall, however, should not be to

carry away the rain-water in the shortest time, but to convey it away in sufficient time not to injure the land, and, at the same time, not to wash out by its force any of the valuable ingredients of the soil or subsoil. Where the inclination of the ground is steeper than is necessary, the best way to retard the motion of the water is to give the drain a little more breadth; for, the shallower the water, it acquires the less force and velocity, these being regulated by the square root of the depth.

5793. Before proceeding farther, it is necessary to ascertain the nature of the subsoil of the field about to be drained; and in my opinion, no better mode can be adopted of ascertaining that fact than by making *exploratory drains* from the bottom to the top of the field. Those drains may be just the ordinary ones cut here and there. When a field presents a uniform surface, but inclining, and does not exceed 10 acres, let at least two exploratory drains be cut from the part at the bottom where the main drain should be placed, to the top. In larger fields one such exploratory drain for every 5 acres may perhaps suffice. Whatever may be the nature of the subsoil, let them be made at once 3 feet deep without hesitation, if the fall at the lowest part will allow it; and as you proceed up the rise of the ground, let them be increased to 4 feet; and let portions of each drain be cut from 1 foot to 2 feet deeper than the above specified depths. Where small undulations exist, the drains should pass right through both the flat and rising ground. In very flat ground, no considerable increase of depth is practicable, further than to preserve the fall. The extensive exposure of the substrata afforded by such exploratory drains, supply satisfactory data for fixing the proper depth of the drains of the field. Should the subsoil be pretty similar in all the experimental drains, it may reasonably be concluded that it is so over the whole field; but should it prove otherwise in different parts, then the nature of the difference should be strictly observed. A correct judgment, however, of the true nature of the subsoils, cannot be formed immediately on the opening of the drains; for time must be allowed the water from the adjoining ground to find its way into them, and several days may elapse ere the

water will make its appearance in some of them. When it is believed the drains have received as much water as they can in fair weather, the part which supplies the most should be observed, whether the water comes into the drain from a line nearer its top or bottom. Should rain fall during the experiment, let its effects be observed. It is better that parts of the sides of the drains fall in during the dry or the wet weather, as the new fractured ground affords indications of the natural structure of the subsoil better than the newly cut ground by the spade. Whatever may be the facts observed, it should be borne in mind that the durability of the drains will depend upon their standing on impervious matter, as it prevents the escape of the water by any other channel than the duct; and such a subsoil should therefore be sought for in the experiment. To make the drain more secure still, it should stand upon the impervious matter below the level of the stratum or strata which supply the water. Wherever the drains indicate the depth that draws the most water, it should be adopted for the least depth of the drains to be made on the ground on each side of the particular experimental drain; and should different experimental drains indicate a difference of depth by the same indication, the difference should be adopted for the depth in that particular part of the field. Thus the same field may have drains of different depths, but all its parts will be drained at depths which have indicated the greatest effects in each of their localities. In no case, however, should the drain be made less than 3 feet in depth, unless it be found *impossible* to do so for want of a level; and even means of obtaining that depth should not easily be relinquished. That depth I will show afterwards to be necessary to secure the safety of the drain, under a system of deep ploughing. The experimental drains are converted into drains themselves, in common with the other drains near them, though they will require some repairs before being filled with tiles. Thus knowing the depths of the drains and the nature of the subsoil, data are furnished for also determining the distance between the drains.

5794. The *exploratory* drains having

made you acquainted with the nature of the subsoil, determined the depth of the drains, and fixed the distances between them at the different parts of the field, you are provided with correct data to make a bargain with a contractor to execute the drains. As their cutting should be prosecuted with industry, it is best and most satisfactory to contract with an experienced spadesman, at so much per rood of 6 yards. The rates of cutting drains are generally well understood in every locality. In making a contract, only stout, active, and *skilful* men should be dealt with; for, though men able to do a hard day's work may be found anywhere, if nevertheless deficient in skill and experience, inconveniences will arise, and dissatisfaction be experienced. Unskilled men willingly engage at low rates; but it is wisdom to give such rates to skilful men as will enable them to earn good wages; and the advantages of good work, especially in draining, can never be over-estimated.

5795. Another point, as essential as engaging with a good contractor, is to secure a careful superintendent to measure the sizes of the drains, and to undertake the laying of the tiles. No man's wages are better bestowed for the efficacy of draining than to a skilful superintendent. Under such a person the following state of things can never occur. In bad weather in winter, great extents of drains are cut and left open for an indefinite length of time, without tiles in them, in the intervals of which rain and snow fall, and bring down parts of the sides into the bottom. The spade-work is often roughly and unevenly executed, whereas it should be neatly and correctly done in every size of drain. Drains are made to pass round by the side of comparatively small boulder stones, instead of these being removed, and the drains carried forward in a straight line. The most clayey or sandy part of the earth from the bottom of the drain is often placed upon its very edge, part of which slips down with rain into the drain. The tiles are frequently laid down in a careless manner, instead of being placed as near as possible to the hand of the person who lays them, on the opposite side of the drain upon which the earth has been thrown. Soles are frequently not used. Pipe-tiles are frequently laid in without

regard to their continuous contact or straightness in line. And, to reach the climax of negligence in the whole process, a long time frequently elapses, in the wettest weather, before the earth is returned again above the tiles. Every one of these negligent practices should be scrupulously avoided; and as they entirely originate in neglecting to exercise a strict superintendence over the labourers who have undertaken the work, either on day's wages or by the piece, the farmer himself is most blamable for them. Negligence of superintendence can be his blame alone, and no one's else; for consider what the workmen will naturally do in promoting their own interest in the undertaking. When the same set of men cut the drains and lay the tiles, which is too much the practice, a damp state of weather is more favourable for cutting the solid ground than laying the tiles, and therefore they go on cutting drains, day after day, as if they had nothing else to do; thereby exposing a large extent of drain to the weather, which, on continuing wet, brings down much of its sides. Should the rain still continue, the workmen can neither bottom out the drain nor lay the tiles, and the matter becomes daily worse. In a season when rain may be expected to fall, had a superintendent caused the tiles to be laid, or had laid them himself, the drain would have been filled before it would have become too wet to work in. Then, should a sudden frost follow, it moulders down still more of the earth from both sides, which, absorbing the rain or snow that follows, is converted into sludge that cannot be taken out until it becomes firm. On the other hand, fine dry weather occurs, and induces the men to lay the tiles; and they continue laying them, as if certain the dry weather will continue until they are ready to return the earth into the drain. When they want to return the earth, it is found too wet one day and too hard with frost another, to put into the drain; and so the laid tiles lie exposed to whatever change of weather may happen to come. Every one of these bad effects would be avoided, were a strict superintendence exercised over the work and the workmen. When left to their own will, they naturally execute the part of the work most conducive to their own interest when working by the piece, and most pleasant

to their own feelings, when on day's wages, irrespective of the ultimate consequences to the work, about which they may entertain no apprehensions at all. They have no desire to do harm; but as they cannot, and do not think of anticipating the weather beyond the present day, they naturally work to their own convenience. It is thus worse than folly, on the part of the farmer, to neglect the constant superintendence of so permanent an operation as draining. The time of a griever or steward is too frequently considered thrown away when superintending drainers. The griever's time may be fully occupied elsewhere, and but little fear need be entertained of men on piece-work working less than will secure them good wages; but it is not the apprehension of a small quantity of work being done any day that causes uneasiness to the drainer — it is its *quality* and *efficiency* — and to secure these, superintendence over the workmen is absolutely requisite. Should the griever have no leisure, another competent person should be appointed to superintend, and by his laying the tiles a saving will be effected; whilst, his being constantly on the spot attending to his own duties, the workmen will be directed by him to cut the drains and return the earth whenever the state of each is best adapted for the work; and besides, when they are not bound to return the whole earth into the drain, the superintendent intimates to the steward in good time to send the ploughs to do it. With proper superintendence, the work will be conducted with regularity, and executed in the fittest time, and therefore in the most satisfactory manner.

5796. Matters having thus far been properly arranged, the commencement in actual operations is to fix the position of the *main drain* to convey away the water brought by the other drains, from the most distant parts of the field. As main drains are only intended to lead away water from other drains, they should *occupy the lowest part of the field*, whether along the bottom, the sides, or the middle. If the field is so flat as to have very little fall, the water is directed towards the main drain by making it deeper than the general depth of the other drains, and as deep as the fall of the outlet will allow.

If the field has a uniform declivity one way; one main drain along the bottom will take away all the water, provided the drains are not too long. If it has an undulated surface, every hollow of any extent, and every *deep* hollow of however limited extent, should be furnished with a main drain. No main drain should be placed nearer than 5 yards to any tree in the field that may possibly push its roots into it. The ditch of a hedge should not be converted into a main drain, though the roots of the hedge should lie in the opposite direction, and the ditch merely receive surface water from the field. The main drain should be cut out of the solid ground, and not be nearer than 3 yards to the ditch lip, or 5 yards to the hedge; and the ditch, now no longer required to collect surface water, should be converted into a small drain, and filled up with earth from the head-ridge.

5797. As main drains occupy the lowest parts of fields, *the fall along them* cannot generally be so great as in other parts of the field; and conveying more water, they do not require so great a fall as smaller drains. In the case of a level field, the fall may most depend on cutting them deeper at the outlet than at the farthest end; but whenever the fall is so small, the lower part of the drain should rather be deepened than the duct made considerably wider. Should the fall vary in the course of the drain, the least rapid parts should be made the narrowest. The main drain, on the same level, should be rather larger at the lower than at the upper end, having more water to convey; but should there be naturally a greater fall at the lower end, the drain should still be larger, to retard the force of the water. I would recommend an increase of fall along the last few yards towards the outlet, to expedite the egress of the water, and promote an accelerated speed along the whole length of the drain, unless the fall is rapid enough throughout, and then no increase of acceleration at the termination is required. With the view of accelerating the speed of the water from the other drains, main drains, on level ground, where practicable, should be made 6 inches deeper than the small ones which fall into them. This is objected to by some drainers—Mr Parkes amongst

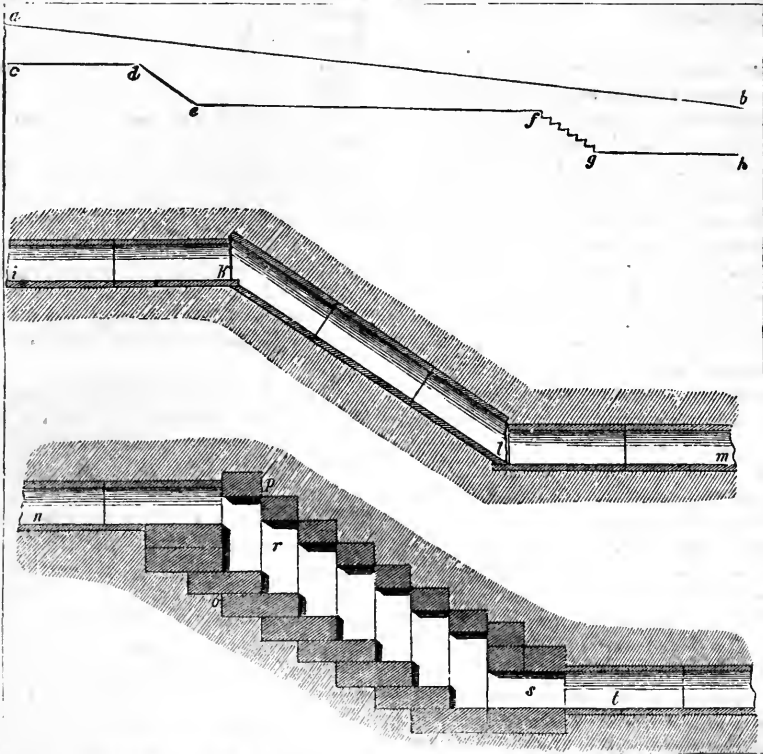
others—who prefer having the mains and small drains on the same level. But the greater depth of the main drain has the advantage of keeping the outfalls of the small drains always clear of any sediment that might otherwise lodge in them, and of back-water from the main drain itself. It is not necessary that the water from the small drains should fall suddenly the six inches into the main, for if the material of the subsoil is loose, that fall may endanger the seat of the main tiles. All that is requisite is, that the main should receive the water with an increased velocity by a greater inclination of the last few tiles in the small drains; and the velocity should be the smaller the looser the materials the subsoil is composed of.

5798. Should it so happen, from the nature of the ground, that the fall in a main drain is too rapid for the safety of the materials constructing it, it should be divided into lengths, which should each have a proper fall, and join the next by an inclined plane. The inclined planes should be furnished with ducts built of brick or stone, plain, or like steps of stairs. Fig. 494 illustrates this contrivance, where *a b* is supposed to represent the entire rapid fall on a main drain at 1 in 10, which is more than it should have to convey a considerable quantity of water. To lessen this fall, let the drain be cut in the form represented by the devious line, *c h*, which consists of, first, a nearly level part at the highest end, *c d*; then an inclined plane, *d e*; again a nearly level part, *e f*; again an inclined plane, *f g*; and lastly, of a less level part, *g h*, to allow the water to flow rapidly away at the outlet. The inclined parts may be filled in in various ways—one with tiles, as from *k* to *l*, where they must be so broken at the end as to fit those on the level at *k* and *l*. In using open tiles in such an inclination, it is absolutely necessary to protect the ground with soles, which should be prevented from sliding away at the lowest end *l* by resting against a strong stone imbedded there in the ground. The best plan is to line such an inclined plane with troughs of hewn stone, especially if the subsoil is composed of rather loose materials. Conduits of dry stones would be stronger than tiles, and cheaper than hewn stones. Or the incline

may be protected with brick, built dry, and laid like tile-soles, or in a series of steps, by setting two side by side length-

wise on bed, to form one step as at *o*; one upon each end of these to form the upright sides, as at *r*; and one lengthwise, across

Fig. 494.



DIFFERENT FORMS OF DUCTS FOR THE INCLINED PLANES OF DRAINS.

upon the two upright ones, for the cover, as at *p*. Tiles upon the level part easily connect themselves with bricks, as at *n* and *t*. The step form is preferable to the smooth in breaking the fall and impeding the velocity of water, especially towards the lower part of a drain, where it might acquire too much momentum. It would be imprudent to build these steps with lime mortar, which is easily washed away, and would cause masonry with stones to be less firmly compacted than in dry building with pinnings of small stones. It is seldom that such structures are required in drains, but they may be so in certain cases.

5799. The position of the main drains being determined, the next thing is to settle that of the *small drains*, which should be placed and constructed with an

easy descent towards the main drain into which they discharge their waters. They are usually placed in parallel lines up the inclination of the ground; not that all in the same field shall be parallel to one another, but only those in the same plane, into whatever number of planes the surface of the field may be subdivided. In a field of one plane, whether nearly level or with a descent, they should all be parallel to one another, and terminate in the same main drain. Small drains should run *nearly at right angles to the main drains*. Excepting in confined hollows, having steep ascents on both sides, the drains should run parallel with the ridges which correspond with the inclination of the ground. Drains should be carried continuously through each plane of a field, irrespective of the wet or dry appearances of the surface, uniform and complete dryness being

the object aimed at by draining. Portions of land, seemingly dry at one time, may be wet at another; and even when always apparently dry on the surface, may be in a state of injurious wetness below from stagnant water.

5800. Having had the data furnished by the experimental drains, let us see how these facts should guide us in determining the depth we should make the drains. If it is found that a depth of 3 feet affords as much water as 4, or more, it is unnecessary to incur the expense of cutting the additional foot, unless it afford some other advantage; and so all the parts of the field containing the same kind of subsoil should have the drains cut of the same depth. If a porous and tenacious part of the subsoil afford the same results, the drains should be cut of the same depth in both. On the other hand, if 4 feet evidently afford more water from the same kind of subsoil than 3, a 4-foot drain should be preferred without hesitation, because we do not know but that the larger quantity of water is required to be extracted from the land to dry it thoroughly, while the extraction of the smaller quantity might effect very little good. On comparing the flow from porous and retentive subsoils, if it is found that 3 feet and less of the porous afford more water than 4 feet of the retentive, whatever less depth than 3 feet the drain in the porous subsoil may be required, the 4-foot drain in the tenacious one should be made still deeper, until it be seen whether or not the quantity of the water be increased; and if not so by 1 or 2 feet of additional depth, it is inexpedient to go beyond the 4 feet. On comparing porous and retentive subsoils, *the point from which the water issues* is an important element in determining the depth of drains. If it is found that the porous subsoil affords all its water at not more than $2\frac{1}{2}$ feet, where it rests upon retentive matter, it is unnecessary to take it deeper, as far as the supply of water is concerned, than will just afford a trough for the tile in the retentive matter, and which, being 6 inches more, makes the entire depth 36 inches; so that, although the whole water of a drain is supplied at 2 feet, its depth should still be carried to 3 feet, for the drain to be completely out of the way of working the land by deep

ploughing and trenching. If the retentive subsoil parts with its water uniformly down its whole depth of 6 feet, then that depth should be adopted; but when all the water is afforded at 4 feet, it is inexpedient to go deeper, because it will then be out of danger from the work on the surface. If, on the other hand, a retentive subsoil gives out its water freely, by some sand-vein, at 3 feet, and continues retentive at a much lower depth, (5 feet,) it seems inexpedient to go deeper than the 3 feet, except 6 inches more to afford a proper trough for the tile. In such a case, if very porous materials are found in quantity at the 5 feet, it would be proper, while keeping the drain at 3 feet, to make cuts here and there through the bottom of each drain into the porous material below.

5801. Besides the effects on the interior of the drains, the changes upon the surface should be simultaneously observed. If 4 feet evidently dries a larger surface over the same sort of subsoil than 3 feet, while the quantity of water in both is equal, the 4-foot depth should be preferred without hesitation. Attention, under this particular, should be directed to the places where the drains were cut deepest; and if they have produced greater effects upon the surface, while the supply of water is the same, the greater depth should be preferred. We come to the same conclusion we did before, (5793,) that wherever all varieties of subsoils are found, the drains should be cut of the depth specified for the particular variety, even within the same field.

5802. The experimental method just expounded is not usually adopted; the common practice being, on knowing the subsoil of the field to be retentive, to cut the drains of a depth predetermined by the cost willing to be expended on the operation. Such an empirical mode of proceeding is too common in all agricultural operations, whereas the considerate plan I have recommended is founded on principle — on observation of facts — and incurs no unnecessary expense, inasmuch as the experimental drains afterwards serve the purpose of small drains; and, although they should cost more than ordinary drains of the same length, the information they have afforded much more than com-

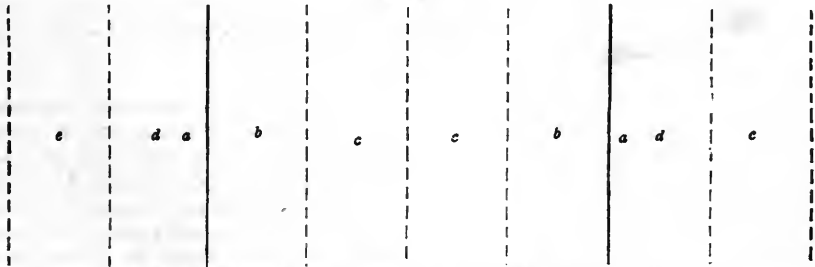
pensates for the additional expense. It may happen that the experimental results coincide with those of the empirical, still it is more satisfactory to have reason and principle to guide us, than parsimony and caprice.

5803. The adoption of the most proper depth of drain is a more important step in draining than many farmers, to judge from their practice, seem aware of. By grudging to cut half a foot, perhaps only 3 inches deeper, the largest amount of benefit may be unattained; for it is perfectly true what the late Mr Stephens said,—that “land may be filled full of small drains, so that the *surface* will appear to be dry; but the land thus attempted to be drained will never produce a crop, either in quality or quantity, equal to land that has been *perfectly* drained,”*—a result which can only be attained by sinking the drains to the depths best suited to the nature of the subsoil; and its nature can only be best ascertained by direct experiment.

5804. The experimental investigations with the drains have brought us to the very important inquiry of the most proper *distance* to be left between the drains. It is evident that this fact can only be determined after the depths of the drains have been fixed upon, as drains which collect

water from a distance through a porous subsoil, need not be placed as close where it comes a short distance through retentive subsoil; and as subsoils vary in the same field, so drains may be placed at different distances within the same field. It is a common practice to occupy the open furrow with a drain, perhaps because its hollow saves a little cutting, though this is a trifle compared to the advantage of selecting the best parts of the ground for drains; but, more probably, it is selected because surface-water runs most quickly to the open furrow. The open furrow, however, has no greater claim for a drain than any other part of a ridge—especially as most of the water received by the drain is from the subsoil, and not directly from the surface; inasmuch as the general surface of a field presents a much greater area than that part of it above drains. The distance at which 4-foot drains will *not* dry a *retentive* subsoil is not left to conjecture, but has been partially determined by experiment. Conceiving that a drain in every furrow, in a tilly subsoil, would be attended with more expense than the anticipated return, a farmer in East Lothian put a drain in every *fourth* furrow; and that they might collect water from that distance, he caused them to be cut 4 feet deep. Fig. 495 will best illus-

Fig. 495.



THE BAD EFFECTS OF TOO GREAT A DISTANCE BETWIXT DRAINS.

trate the results, where the black lines *a a* are the drains between every fourth furrow, and the dotted lines the intermediate undrained furrows, by which it is evident that each drain *a* has to dry two ridges on each side, *b* and *c* on the one hand, and *d* and *e* on the other. On looking at the arrangement of these ridges, we would expect that the two ridges, *b* and

d, being nearest *a*, should be more dried in the same time than the two farther off ones, *c* and *e*, and the result agreed with the expectation. The two ridges, *b* and *d*, nearest *a*, produced 9 bushels of corn more per acre than the two more distant ridges, *c* and *e*, which is a great difference of produce from adjoining ridges under the same treatment and crop; and yet it does

* *Quarterly Journal of Agriculture*, vol. iii., p. 290.

not show the entire advantage which may be obtained by thorough drained over undrained land, because possibly the drain, *a* had also partially drained the distant ridges *c* and *e*. And such being possible, together with the circumstance that none of the ridges having a drain on each side, and all incumbent on tilly subsoil, they could not have been thoroughly drained; and the absolute or comparative drying power of 4-foot drains was thus left unascertained by this experiment.* It may be conceived, however, that had the drains been put into every other instead of every fourth furrow, the produce of all the ridges would have been alike, inasmuch as every one would have been placed in the same position in regard to a drain; and the expectation seems so reasonable, that the practice of many farmers, from what I can observe, is founded upon it. But such an expectation does not contemplate the greatest benefit possible derivable from thorough drainage; for although the ridges did produce alike with a drain on one side only, the product would be no criterion of what it might be with a drain on both sides. This experiment, then, only demonstrates that a deep drain—for a 4-foot one cannot be termed a shallow one—will collect water in a retentive subsoil more certainly across one than two ridges; and the value of the demonstration consists in cautioning others against imitating the practice of those who indicate their belief that a drain cannot have too much to do, by placing them at very wide intervals.

5805. Still, instances might be adduced from practice, where drains of moderate depth, though placed at considerable distance, have dried land. Ridges vary from 12 to 18 feet in breadth; and as in the case related above, the distance between the drains might be from 48 to 72 feet, which we are warranted in regarding as too far asunder. Yet Mr Thomas Hammond, near Penhurst, in Kent, has dried uniform clay land, with drains from $3\frac{1}{2}$ to 4 feet deep, at 40 feet apart; and clay land containing some stones, he has dried with 4-foot drains at 50 feet apart. Mr Kep-

ping, Hudlow, in Kent, has dried soil of various quality, of clay, gravel, and sandy loam, with 4-foot drains at 66 feet apart. And even with stone drains, of from only $2\frac{1}{2}$ to 3 feet at 30 feet apart, Mr Bartlett, Butleigh, in Somersetshire, has drained clay and stiff loam for the upper soil with stones in the subsoil.† Mr Mechi renders strong clay land dry with drains 5-feet below rising ground, and averaging nearly 4 feet all over the field, at 40 feet distance; while lighter and more porous soils he drains with 6 and 7-foot deep drains, at intervals varying from 70 to 90 feet.‡ A farmer in the east of Fife, within the last twenty years, sunk a shaft in one of his fields with a view to working coal; but after descending about 40 feet he was obliged to relinquish his intention, on account of the shaft being overpowered with water. The shaft was filled up, and a conduited drain, of about 5 feet deep, formed from it to the sea-side, discharges a very large quantity of water to this day. After filling up the shaft, he intended to have drained the field, which consists of 16 acres of porous soil resting on clay and rock, but soon discovered that the shaft had effectually dried the entire field. It is quite reasonable to suppose that if one outlet only is made of a sufficient size to run off the confined water under the surface, more outlets are unnecessary. A shaft for a coal-pit cannot be called a drain, but it operates as a reservoir for collecting water, from which the water may be discharged by a small drain.

5806. On the other hand, instances may be adduced of drains, placed at wide intervals, and of 4 feet deep at least, having failed to drain strong clays. Mr W. Bullock Webster produces several instances, in different parts of England, where drains of from 30 to 36 inches deep, and from 18 to 22 feet apart, have rendered strong clay land dry, when 4 feet drains at 40 feet apart had failed to do so.§ The late Mr Wilkie of Ormiston Hill, in West-Lothian, put in drains 4 feet deep, and from 30 to 36 feet asunder, which failed to dry a clay subsoil, and which his son, the present proprietor, has

* *Quarterly Journal of Agriculture*, vol. viii. p. 539.

† *Journal of the Agricultural Society of England*, vol. vi. p. 126.

‡ *Mechi's Experience in Drainage*, p. v.—Preface.

§ *Journal of the Agricultural Society of England*, vol. ix. p. 237-48.

succeeded in drying with 30-inch deep drains between the deeper ones.*

5807. The conclusion to be drawn from all these instances is, not that the experiment of wide draining in East Lothian was ill conducted, but that subsoils of various qualities require drains of various depths and at various distances. It is therefore unwise in a farmer to fix the distance and depth of drains before he has ascertained the nature of the subsoil, and he can only ascertain its nature by direct experiment and observation, somewhat in the manner recommended by the test of exploratory drains (5793.)

5808. My opinion is, that in a partially impervious subsoil, such as is most common in Scotland, 3-foot drains cannot be expected to dry more than 15 or 16 feet ridges, but that 4-foot ones will dry as effectually a distance not exceeding 24 feet. In porous subsoils, 3-foot drains may dry 20 feet spaces with as great if not greater effect than the above. In deep hazel loam resting on impervious subsoil—a not uncommon combination of soil and subsoil in the turnip districts of Scotland—4-foot drains will dry, I have no doubt, a distance of 30 feet. I would feel reluctance to recommend drains at more than 30 feet distance, unless the arrangement of the subsoil was peculiar, such as a porous substance of considerable depth, subdivided by beds of clay, through the whole of which 4 or 5 feet drains, at double that distance, might dry the soil of a large field. It seems to me somewhat inconsistent in those who believe that water ought not to enter by the top of a drain, and that strong clay on being dried becomes fissured, to recommend shallow drains of 24 inches in it, since it is evident that the greater the depth the clay is dried, the larger, more numerous, and more connected will the fissures be in it; and the more readily will the water be brought nearer to them by the duct. Perhaps the plastic clays of England do not fissure, in which case deep drains do not seem to be required in so uniform a texture. In draining clay, it is not merely the rain that falls upon it that has to be removed, but the water also which is naturally

retained in it by strong affinity, and which must first be extracted and prevented remaining, before any effect can be obtained from either a deep or a shallow drain. It seems probable that the deeper drain affords the more easy means of removing from clay its natural moisture by offering it a greater depth for simple gravity to act upon. Water cannot be retained in porous subsoils, because of the free action of gravity, but in clay a certain depth of drain seems requisite to allow gravity to act sensibly upon the water; and it is that power alone which puts it in motion through clay towards the drain: and perhaps a certain depth of drain is also requisite to cause gravity to act so powerfully as to overcome the natural affinity of clay for water. With our present experience, however, I do not see the utility of cutting drains as deep as 6 or 8 feet, merely to extend the space between the drains, when perhaps the same effect might be obtained by 3 or even 4 feet drains at narrower intervals, unless very deep drains at very wide intervals can be executed with more economy. Experience has yet much to elicit in regard to the distances that should be left between sub-drains of different depths in different soils to effect the best results.

5809. The cutting of the drains of a field commences with that of the principal main drain, which occupies the lowest side of the field, and the lowest end of the main drain constitutes the outlet from which the entire drainage of the field flows, when all the water from it is led off in one direction. The position of the principal main drain, I have said, is not nearer than 3 yards to the ditch lip, or 5 yards to the fence (5796.) Its breadth is set off with the garden line (5604) by the first workman, whilst his two assistants dig and shovel out the surface mould upon the side of the drain nearest the fence, with the common spade fig. 237 and pointed shovel, fig. 453.

5810. Whilst the mould is thus thrown out, the carts should lay down the tiles along the open side next the field; or on the same place before the drain is begun to be cut, after the line of its direction has

* *North British Agriculturist*, November 14, 1850, p. 725.

been marked off. To be certain that the requisite number of tiles are laid down, they should be placed end to end along the whole line; and in the case of tile and sole, a sole should be placed against the side of every tile nearest the drain: broken soles will do well enough. These preliminary arrangements should be carefully attended to, or much inconvenience may be occasioned in carrying tiles to the person who lays them. The ploughman who carries them in the cart should be instructed in all these particulars, else some mistake may occur, as few ploughmen long reflect on the consequences of what they are doing, and only strive to have their own part of a work as soon off their hands as possible. If, by his inadvertence, more or fewer tiles are laid down than required, part of the time of a yoking of a pair of horses will have been lost in laying them down, and part of another yoking afterwards lost in leading away the unused ones to another place; while the tiles, on being so often handled, run the risk of being broken.

5811. Should the drain be very wet, owing to a great fall of rain, or the cut drawing much water from the porosity of the subsoil, it is better to leave off the digging at this stage of the work, and proceed to set off another length of line at the top; and should those circumstances continue, it is expedient to remove the mould from the whole length of the main drain in hand, to allow the water time to run off, and the ground below to dry. This precaution is more necessary in digging narrow than deep drains, where no room can be found for planks to support the falling sides. When the ground becomes dry and firm, the digging may proceed to the bottom at once.

5812. After the mould has been removed, the subsoil is loosened by one man, either with the foot-pick, fig. 247, or the hand-pick, fig. 452, according as the ground is stony or otherwise, the foot-pick being best adapted for displacing stones. The pick-loosened earth is removed by a second man working backwards, with the narrow spade, fig. 496, having a mouth 6 inches wide, following up the picker, and putting aside the earth upon the formerly cast out mould. The principal workman

follows with the pointed shovel, fig. 453, shovelling out the loose earth and trimming the sides of the drain. It may happen that the subsoil requires no picking, in which case the spade, fig. 496, and pointed shovel are used at once; but this rarely is the case with the subsoils of Scotland. It will more likely require another picking in the lower spit, when the first man takes either the foot or hand pick, and loosens the earth in preparation for the principal man throwing out the loosened

Fig. 496.



THE NARROW DRAIN SPADE.

soil with the same narrow spade, fig. 496, with which he trims the sides of the drain, and finishes the bottom neatly.

5813. In very dry weather drains are dug with great labour, and prove an unprofitable speculation to the contractors. In that state of ground, it would be better

Fig. 497.



DRAW DRAIN-SCOOP.

dry earth and small stones with a narrow

for the drains themselves to defer cutting them until a shower falls. It is right to cut the drain a little deeper at every sudden though small rise, and a little shallower where a trifling hollow occurs, than exactly to follow the slight undulations of the surface.

5814. Should the drain have stood for some days new cut, immediately before the man proceeds to lay the sole-tiles, the wet sludgy matter at the bottom should be removed with the draw-earth drain-scoop, fig. 497; and

draw-hoe, fig. 498, having a 2-foot helve,

Fig. 498.



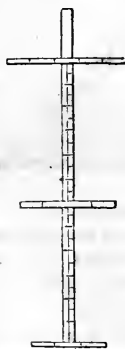
THE NARROW DRAW-HOE FOR DRAINS.

and mouth, 3 inches in width: costing 1s.

5815. For convenience and clean work, the points where the small drains are to enter the main drain should be marked off, that when the cutting proceeds the ends of the small ones may be cut at the same time to the depth they are intended to be. The main drain should be 6 inches deeper than the small ones, if the fall of the outlet permit; if not, the 6 inches must be obtained as near as possible at the ends of the small drains, where they enter the main drain.

5816. When a division of the drain has been completely cleared out, the superintendent ascertains that the dimensions and fall are in terms of the contract, before any tiles are laid on the bottom. Instead of taking the dimensions with a tape-line or foot-rule, which are inconvenient for the purpose, a rod of the form of fig. 499 will

Fig. 499.



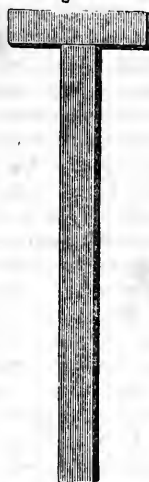
THE DRAIN-GAUGE.

be found most convenient, most certain, and most quickly applied. The rod, subdivided into feet and inches, is put down with the arms extending along the drain, to ascertain the depth, and then turned gently round while resting on its end upon the bottom of the drain, until the points of the arms touch the earth on both sides. If the arms cannot come round square to the sides, the drain is narrower than was intended, which can do no harm; but if they cannot touch both sides, it is wider than necessary, and should be objected to, though it cannot be remedied.

5817. The uniform fall in a drain in uniform ground is best ascertained by means of three levelling staffs, fig. 500, two being about 2 feet in length, and one to

suit itself in the drain to the height of the others, with cross-heads 9 inches long. One staff is held perpendicularly on the ground at the upper end of the drain, and another similarly at the lower end; and the third, adjusted, is gradually moved from one end of the drain to the other, the superintendent placing himself at one end of the drain, and, bringing his eye on a line with the upper edges of the cross-heads of the two extreme staffs, observes whether

Fig. 500.



THE LEVELLING STAFF, FOR TESTING THE UNIFORM FALL IN DRAINS.

the upper edge of the third staff keeps in the line of the other two. If it does, then the fall of the bottom of the drain is uniform; but where it sinks below the other two, the bottom has been too much scooped out, and should be filled up with earth; and where it rises above them, the bottom is too high, and must be cut down. When the staffs are painted each of a contrasting colour, such as white, red, blue, they are easily distinguished in use.

5818. The fall of the ground may be ascertained, by the workmen, by a simple contrivance. Where the bottom of the drain is cleared out, a damming of 3 to 4 inches high will intercept and collect the water seeking its way along the bottom, and where the water line cuts the ground as far up as it should do, the specified fall has been preserved. A succession of such dammings will preserve the fall all the way up the drain. When the drain is dry, a few bucketfuls of water thrown in will detect the fall in the same manner. It is only, however, on comparatively level ground that such expedients for ascertaining the fall are at all requisite to be used by the workmen.

5819. In filling drains, it is a common practice with farmers to put in the mate-

rials as the digging of the drain progresses, which I consider an objectionable proceeding. I think the whole length of the drain in hand should be cleared out to the specified dimensions before the filling commences; because the work should be inspected in the first place, in accordance with the specifications, and inspection implies measurement of the contents in depth and breadth, and ascertainment of the fall of the bottom—whether it be uniform throughout, where the slope of the ground is so—or sufficient, where the general fall of the ground is small—or preserved in all places, where the ground happens to be not uniform. These are not trifling considerations, but essential; inasmuch as the efficiency of a drain as a conductor of water entirely depends upon them. An unanswerable reason for filling drains from the upper to the lower end, in flat ground, is the ease of clearing the bottom down the natural declivity of the ground; and on doing so, it is at once seen whether the fall has been preserved. In very deep drains, I was once of opinion that they should in all cases be filled as cut; but subsequent observation has convinced me that it is better to risk a little of the sides falling in than to lose the fall on level ground. On acclivities, drains may be filled in from either end with impunity; but still cut entirely out before being filled.

5820. The drain is now ready for the reception of the tiles. The person intrusted with the laying the tiles in the drains should be accustomed to the work, and otherwise a good workman, possessing judgment and common sense. If he is not the superintendent or a hired servant, he should be paid day's wages, that he may have no temptation to execute the work in a slovenly manner; and to enable him to do it well, let him take even more time at first than is deemed necessary. According to the circumstances of the case, it will soon be ascertained how much work of this kind a man ought to do in a day. This person should remain much at the bottom of the drains; and not having too many particulars to attend to, he is enabled, with an *assistant* to hand him the materials from the ground, to do the work with greater precision and expedition; and the best assistant he can have is a field-worker. A woman not only receives less wages

than a man, but is most dexterous in handing light materials, such as tiles.

5821. The sole should be firmly laid and imbedded a little in the earth. Should it ride upon any point, such as a small stone or hard lump of earth, the obstacle should be removed with a mason's narrow trowel, fig.

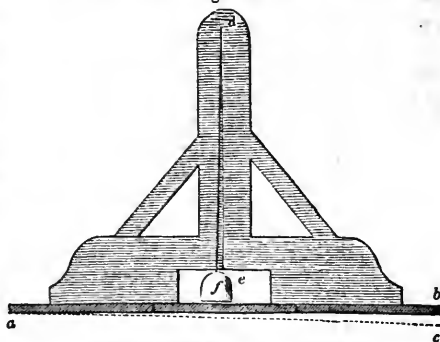
Fig. 501.



THE TROWEL FOR DRAINS.

501, 7 inches long in the blade *a*, 5 inches in the handle *c*, and the crank at *b* $1\frac{1}{2}$ -inch;—a very convenient instrument for this purpose. In cast-steel it costs 2s.; in common steel, 1s. 3d. After laying 3 soles in length, he examines if they are straight in the face, and neither rise nor fall more than the fall of the drain. As a safe guide, in cases where the fall is not decidedly cognisable by the sight, a mason's plumb-level, such as fig. 502, is a convenient

Fig. 502.



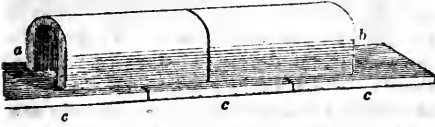
THE DRAINER'S PLUMB-LEVEL.

instrument. A mark at which the plummet line *df* will subtend an angle with the plumb-line *de* equal to the angle of the fall of the drain, should be made at the top of the opening *e*, which may be supposed to be where the plummet *f* at present hangs; by which arrangement it is demonstrable that the angle thus set off at *edf* must always be equal to the angle *bac*, which is the angle of the inclination of the fall.

5822. After 3 soles are thus placed, 2 tiles are set upon them, as represented in fig. 503—that is, the tiles *a* and *b* are so placed as that their joinings shall meet on the intermediate spaces between those of

the soles *ccc*; and this is done for the obvious reason that, should any commo-

Fig. 503.



DRAIN-TILES PROPERLY SET UPON TILE-SOLES.

tion disturb one of the soles, neither of the tiles, partially standing upon it, shall be disturbed. The man who places the tiles takes care not to displace them in the least after they are set; and, to secure them in their relative places, he puts earth firmly between them and the sides of the drain as high as the top of the tiles, the earth being obtained from the subsoil thrown out. In ordinary cases of water in a main drain, a tile of 4 inches wide and 5 inches high inside is a good size; and from this size they vary to $5\frac{3}{4}$ inches in width to $6\frac{1}{2}$ inches in height. Although the size of the tile varies, the width of the main-drain sole is always the same—that is, 10 inches. Taking the useful tile of 4 inches in width and 5 inches in height, its thickness being $\frac{3}{4}$ inch, there will be a space left on each side of $2\frac{1}{4}$ inches, which is too much. The width of the drain is thus regulated by the breadth of the sole, which in some cases is too wide.

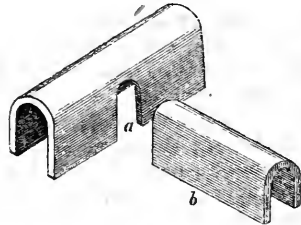
5823. It is the practice of some drainers to put a half-sole under every joining of two tiles, leaving the intermediate space of the bottom without a sole, imagining that the half-soles give sufficient steadiness to tiles on what they call hard clay, whilst it saves half the number of soles. The clay, when in contact with water, too soon becomes soft to enable the drainer to adopt this questionable practice; and as to the effect of half-soles, I conceive that water would act more partially on clay under them, and cause greater inequalities and displacement of tiles, than if no soles were used at all.

5824. The joining of tiles where drains meet deserves attention. The usual practice is to break a piece off the corner of 1 or 2 main-drain tiles, where those of the small drains connect with them. Another plan is to set 2 main-drain tiles so far asunder as that the inside width of the small ones shall just occupy the space;

and if the opening on the opposite side is not occupied by small tiles, it is covered up with pieces of broken tiles or stones. A better plan than either is to place the end of the small tile upon the top of the main, when the water will find its way into the latter; and this plan implies that the main is on a lower level than the small drain.

5825. Main-tiles are sometimes made with an opening in one side for the reception of the end of the small tile; and to answer this purpose in particular situations, where the small tiles cannot conveniently conjoin with the larger main tiles, half and quarter lengths of main and small tiles are made, which form a good junction with one another. Fig. 504 represents this

Fig. 504.



THE JUNCTION OF A COMMON TILE WITH A MAIN.

mode of joining a small with a main tile; but the small tile *b* is not actually inserted into the opening *a* of the main tile, the better to show the relative sizes and positions of both tiles.

5826. Preparations for the junction of the main drain with the small drain tiles should be made during the laying of the main drain ones; for if the main tiles are disturbed when the small ones are being laid, they will be displaced, and check the current of water which is to run in them. Whichever plan is adopted for letting in the small tiles, the tile-layer should be provided with a 6-foot rod, marked off in feet and inches, to measure the distances exactly between the small drains which had been marked off (5815.) When the plan of laying the small tiles upon the top of the main ones is adopted, no preparation for the small tiles is required while laying the main ones, which is one of its advantages.

5827. The mouth of the main drain at its outlet, whether in a ditch or river

should be protected with masonry, and dry masonry will do. The last sole, which should be of stone, should project as far beyond the mouth as to throw the water either directly upon the bottom, or upon masonry built up the side of the ditch. The masonry should be founded below the bottom of the ditch, and built perpendicularly in the back, with its face having the slope of the ditch. The sloping face may be made straight, to allow the water to slip quietly into the ditch, or like the steps of a stair, over which it will descend with broken force. It is proper to have an iron grating on the end of the outlet, to prevent vermin creeping up the drain: not that they can injure tiles while alive, but in creeping far up, and on dying, their bodies for a time may cause a stagnation of the water in the drain above them.

5828. If the ground fall uniformly towards the main drain over the whole field, the small drains should be proceeded with immediately after the main drain is finished; but should hollows occur in the field, a *sub-main drain* should be made along the lowest part of each, to receive the drainage of the ground around it, and transmit it to the main drain. The size of sub-main drains is determined by the extent of drainage they have to effect; and should any one have as much to do as the main, it should have the same capacity.

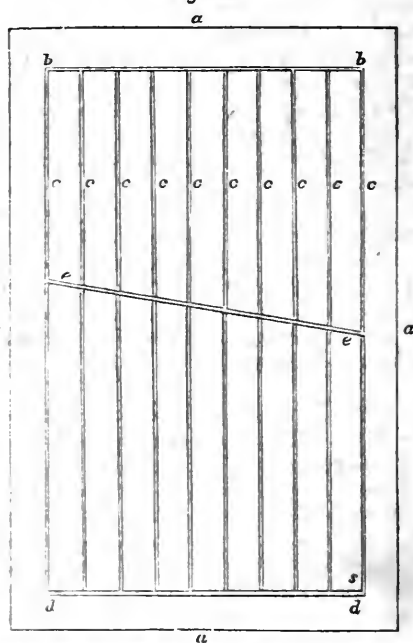
5829. Sub-main drains are made in all respects in the same manner as main drains; but the peculiarity may attend them of having to receive small drains on both sides, when there will be double the number of joinings. To avoid accumulation of sediment, the small drains should not enter the sub-main directly opposite to each other, but alternately; nor should they enter at right angles, but acutely with the flow of water.

5830. A sub-main drain should be as much below the level of the small drains as is the main itself when it receives the small drains directly; and the main should be as much below the level of the sub-main as the latter is below the small ones. The simple way of effecting the latter purpose is, to make the main deeper after the sub-main has joined it.

5831. The *small drains* may now be proceeded with. In a field having a uniform surface, there is no difficulty in bringing the drains directly down the inclined ground into the main drain. Where hollows occur, the drainage belonging to each should be distinctly marked off from the rest, that no interference may arise in the execution of the work; and the markings should be traced along the *water-shed of the ground*—the line from which the water will descend to the sub-main. The markings may be made with pins.

5832. Fig. 505 shows the parallelism of the common drains along a field, where

Fig. 505.



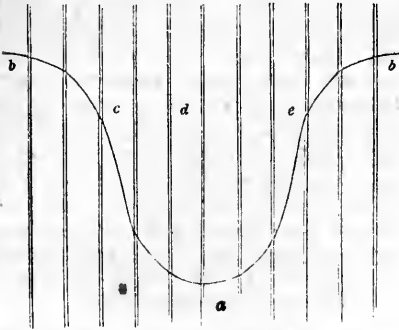
PARALLEL DRAINS IN THE SAME PLANE OF INCLINATION OF THE GROUND.

a a a a are the four fences of it; *b b* and *d d* the headridges; *d d* the main drain along the side of the lower headridge; *s* its outlet at the lowest point; and *c c c* the common drains.

5833. When the field has an undulated surface, the same principle of parallelism is differently arranged. A sub-main drain is carried up the hollowest part, and the small ones are brought to it in parallels down the inclinations. So favourable an

arrangement for the speedy riddance of water is not enough attended to. Thus the common practice is to run all the small drains, *b c d e b*, fig. 506, parallel to one

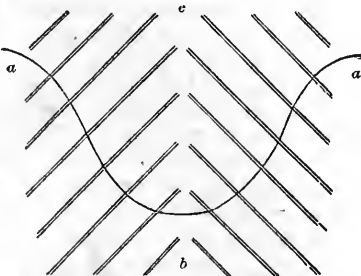
Fig. 506.



DRAINS IMPROPERLY MADE PARALLEL IN RESPECTIVE OF THE INCLINATION OF THE GROUND.

another, through the length of a field, even along hollows, such as are represented by the curved line *b a b*, so that the parallel drains *c* to *e*, on both sides of the hollow *d a*, are run along their declivitous faces, in a horizontal instead of a vertical direction. The probable effect of giving such a direction to the drains is to miss the drainage of both sides; for where any vein of sand dips out at the surface of the declivitous ground, the drain may run parallel with and just below it and miss it, instead of dividing it along the dip, as it should do; and though it were not entirely missed, but bisected along its length; and across the dip, the sand would then be brought down from the upper part of the ground into the drain, enter the duct in quantity, and render it inoperative. Such hollow ground should have the drains placed as in fig.

Fig. 507.



DRAINS MADE PARALLEL IN ACCORDANCE WITH THE INCLINATION OF THE GROUND.

507, *a b a*, to run right up and down the declivitous faces from *c* to *a*, towards the sub-

main drain which should occupy the line *b c*. This circumstantial plan is just as easily executed as the other indiscriminate one of treating all forms of ground in a field alike.

5834. In commencing the small drains from the fence at the lowest side of the field, they may be set off from each other at the distances determined on from the nature of the subsoil, as ascertained by the exploratory drains, (5793;) and should it be determined to have a drain in every ridge, it is not necessary to make the drain in the open furrow; it may be made in any part of the ridge.

5835. Small drains are made much

Fig. 509.

Fig. 508.



THE NARROWEST DRAIN SPADE.



THE PUSHING DRAIN-SCOOP.

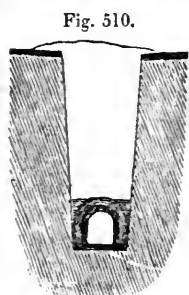
narrower than mains, to save the expense of digging out an unnecessary quantity of earth. To effect this, the narrowest spade, fig. 508, is an appropriate instrument. It is only 4 inches wide at the mouth, and is provided with a stud in front to press the heel upon when the workman pushes the blade into the subsoil. It serves to throw out some of the earth that had been loosened by the last picking, and to trim the sides of the drain. But the loose earth at the bottom of a drain is best removed with a scoop. When the earth is dry, a pushing-scoop, fig. 509, will answer best; but when wet and sludgy, the draw-earth drain-scoop, fig. 497, is the best. The scoop finishes the bottom of a drain neatly.

5836. Small drains are cast out, gauged, (5816) and examined for the fall, (5817) before being filled up, and the filling materials should be laid down in the same order as in the case of mains, (5810.)

5837. The tiles for small drains are smaller than for mains and sub-mains, being from $2\frac{1}{2}$ to 3 inches wide, and from 3 to 4 inches high, inside measure, the latter being considered a large tile. A substantial tile will last much longer than a slight one, and the probability is, that the larger is the more substantial; but this may not be the case, so it is proper to examine them before purchase. Durability is of more importance than cheapness. Soles are also required for small drains; for give no credence to the absurd assumption, that clay will retain its hardness at the bottom of a drain, because it happened to be so when first laid open by the spade. Soles for small drains are of different breadths, being 5 inches at some places, and 7 inches at others: the former, 5 inches, I should conceive rather narrow for most purposes; for take even the narrowest tiles made, $2\frac{1}{2}$ inches inside—these are moulded at $5\text{-}8\text{ths}$ inch thick—and, allowing them to shrink $1\text{-}8\text{th}$ in the kiln, the thickness of both sides will be 1 inch. The extreme breadth of the tile being thus $3\frac{1}{2}$ inches, leaves only $1\frac{1}{2}$ inch to divide between both sides of the tiles on a 5-inch sole. But as most soles for small drains are made of the same breadth, take a 3-inch tile, and it will be found, by the same mode of calculation, that only half-inch on each side of a 5-inch sole will be left, which is little enough space to afford perfect steadiness to the tile; and less than this should not

be trusted. In all other respects, the laying of the sole and tile in the small drains is conducted in precisely the same manner as in the mains and sub-mains, (5821.)

5838. A finished drain with tile and sole is represented by fig. 510.



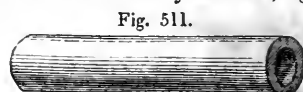
THE SMALL TILE AND SOLE-DRAIN.

5839. In all cases of thorough-draining,

a small drain should connect the tops of the others at the upper end of the field, as *b b*, fig. 505, does the drains *c c c*; its object being to dry the upper head-ridge, and protect the upper ends of the ridges from any ooziings of water that may come from the ditch or rising ground beyond the field. If the ditch convey no water, and there are no hedges or hedge-row trees, this connecting drain may be made in the ditch itself, as in *a*, and the ends of the small drains *c* brought across the head-ridge *b a* into *a*; but, should water, or hedge, or trees be connected with the ditch, the drain should be kept on the head-ridge, not nearer than three yards from its lip, and be of the same depth as, though not deeper than, the small drains.

5840. When drains are made in very long ridges, much exceeding 200 yards, it is recommended to have a *sub-main* drain in an oblique direction across them, as represented by *ee*, fig. 505. It should be cut the same depth as the drains above it, and those below it should be disjoined by a narrow strip of ground; but a better plan is to make the sub-main *ee*, 7 inches deeper than the drains, and intercept the water by it from the drains, which should be continued over it. Where the sub-main *ee* falls into the small drain *b d*, at the side of the field at *e*, the portion of the latter below *e* to *s* should be converted into a sub-main, and made accordingly.

5841. I believe that a more substantial drain cannot be made than with tile and sole, the overlapping of the tile over the sole giving them a stability which no other arrangement of tiles is capable of affording. They were much used when the tiles were first introduced, but their high price rendered draining with them an expensive process. In later years the pipe-tile has superseded the use of the tile and sole, wherever the clay fit for their manufacture can be found, not only on account of their comparative cheapness, but of their quick and easy handling in the manufacture and use. Its simplest form is the cylindrical, fig. 511,



THE CYLINDRICAL PIPE-TILE.

15 inches in length, 2 inches diameter in the bore, and $\frac{3}{4}$ ths inch thick. To reduce its cost to the lowest degree, it is made in many parts of England only 12 inches in length, 1 inch in the bore, and with a corresponding thinness. A good objection to such pipes is in the attempt to attain a refinement in economy by using them of so diminutive a size, that they might be choked up with the smallest quantity of matter, when all the water they can convey must flow with but little force. The cylindrical form is practically objectionable too, on account of the difficulty of placing it in continuation in a firm position upon the flat surface of the bottom of the drain, to which it is scarcely possible to give a rounded form with the tools in use. Of what intrinsic value, then, is the cylindrical form? It is evident that, were the slightest depression to take place at either end of a pipe, or were the end of one pipe to be placed a little aside from that of its neighbour, the continuity of the passage for water would be broken. Small pipes are recommended to be laid in continuity, by means of a rod of iron which goes into the pipe as far as a shoulder permits it; and its helve, being at right angles, enables the workman to lay the pipe in the drain, while standing on the ground, and retain it in its place by the pressure of the shoulder until some of the subsoil earth is thrown upon it by another person, after which the instrument is withdrawn. This seems a trifling and uncertain way of performing so important a work in draining as the laying of the tiles. Inch pipe-tiles are very properly not in so much favour as they used to be.

5842. Various devices have been contrived to keep cylindrical pipes in continuation in a drain, without the trouble implied in the above method; and amongst others is the placing a short collar to act as a coupling-box to connect the ends of the pipes, as is shown in fig. 512, into which

Fig. 512.



CYLINDRICAL PIPE-TILES CONNECTED BY A COLLAR.

collar the water is allowed to pass through holes perforated in it. The device doubtless answers the purpose, but a collar gives

as much trouble in making and handling as a pipe itself, and must be nearly as costly; and unless the collars are sunk into the ground, to allow the entire length of the pipes to rest with an equal bearing upon the bottom of the drain, the pipes may be fractured between the collars by the weight of the earth above them, or other casualty. A better plan is to connect the pipes by converting their ends into lobes, as represented in fig. 513, in which

Fig. 513.



CYLINDRICAL PIPE-TILES CONNECTED BY LOBES.

the waved line shows the method of junction. A machine for cutting these lobes was invented by the late Mr Smith of Deanston, but it has not yet come into use. Mr James Wallace, Turriff tile-works, exhibited at the show of the Highland and Agricultural Society, at Glasgow, in August 1850, a clever little hand-machine for cutting the ends of the pipe into two or three lobes adapted to each other, and which is a simplification of Mr Smith's machine. The cutting by Mr Wallace's instrument is a second process, after moulding, when the pipes are partially dry; and although it thus increases the expense of the manufacture, the advantage of the lobed mode of joining pipes is so superior to that of collars, as to preponderate considerably in favour of Mr Wallace's invention. The increased expense, however, is an insuperable objection to using such a contrivance at all; and no necessity exists for it, since pipes of other forms than the cylindrical can be formed well and cheap, to stand firmly enough in a drain.

5843. A very common form of pipe made is that of the horse-shoe, fig. 514, in

Fig. 514.



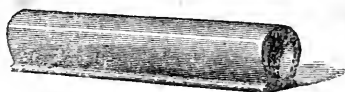
HORSE-SHOE PIPE-TILE.

which the sole occupies the space between the heels, which is the narrowest part of the shoe, and the upper part is rounded off capaciously in the form of the crnst of the hoof. The sole is flat enough for the pipe

to stand firmly upon the ground. There is no obvious objection to this form, nor to the cylindrical with a flat sole.

5844. But the most perfect form of the orifice for a pipe-tile is, in my opinion, the egg-shaped, the sharp end of the egg making a round and narrow channel for the water to run upon with force, and carry any sediment before it; while the blunt end provides a larger space for the water when it may rise to the top after heavy rains. Fig. 515 represents the

Fig. 515.

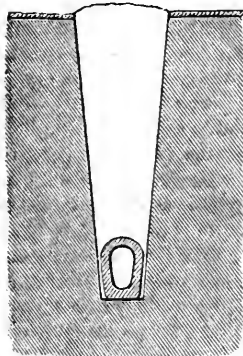


EGG-SHAPED PIPE-TILE.

egg-shaped pipe-tile, having a flat bottom to stand upon. Beyond this form, I conceive little improvement can be effected in the pipe-tile.

5845. A small drain with an egg-shaped

Fig. 516.



EGG-SHAPED PIPE-TILE DRAIN.

tile is represented by fig. 516. Both are of the most convenient length at 15 inches. The machine-made ones are better formed, more firm and solid, and consequently heavier than hand-made ones. A pipe-tile small drain, such as in fig. 515, weighs 4 lb., so that 560 just weigh one ton. Soles and tiles may be used in the main-drains, while pipes might occupy the common drains.

5847. An objection at once occurs to the mind to pipe-tiles, that they cannot permit the water to enter them so freely as sole and tile. The experiments of Mr Parkes, and my own calculations—both to

be stated hereafter—clearly show that the inch-bore pipe is quite sufficient to carry away all the water that can enter the soil after the heaviest rain that ever fell in this country. The experiments of Mr Tweed, near Woolwich, prove besides that water easily permeates through the substance of pipe-tiles. Every one knows that clay dishes would not retain liquids unless they are glazed. It is easier to explain why water gets into clay-pipes, than to devise means to keep it out.

5848. The next procedure is the *filling up of the drains with the earth that was thrown out of them*, and this is returned either with the spade or the plough, or with both. Where the earth has been thrown out on both sides of the drain, a large furrow slice from each side will plough in a considerable quantity of earth; but, as the earth is generally thrown upon only one side, and the plough can then only make it move towards the drain while going in one direction, a more expeditious mode of levelling the ground—which, in the amount of labour of returning the earth into all the small drains of a field, must be considerable—is to cleave down (767) the mound of earth in the first place, and then take in an equal breadth of land on both sides of the drain, and gather it up twice or thrice towards it, which then constitutes a prepared feering; after which the harrows make the ground sufficiently level. This laborious plan, however, is only requisite when much earth has been thrown out at a distance from deep drains; but in ordinary thorough-draining, the plough accomplishes the work with much less trouble; the first two furrows loosen the earth along each side of the mouth of the drain and cause it to fall into it, but in doing this the horses are apt to slip a hind foot into the drain, and overstrain themselves; and such an accident, trifling as it may seem, may be attended with serious injury to the animal. The *safest* mode in all cases for the drain and the horses, is to put the first portion of the earth into the drain with the spade; and this condition should always be made in the agreement with the contractor.

5849. No implement has yet been invented to turn the earth into drains. One should think that a long-mould-board, 3½

to 4 feet in length to any common plough, would effect the object. In working such ploughs it is necessary to give their sole a slight hold of the firm surface, to resist the oblique pressure on the mouldboard by the earth which is being removed into the drain. Advantage is to be gained also by giving the yoke an attachment to the long mould-board as well as to the beam of the plough.

5850. It is an established principle, that all drains should rather receive the water from *below*, than on purpose from above through the soil. Were drains *entirely* filled with loose mould, or other loose materials, it is evident that the rain, in descending directly through them, would arrive at the bottom loaded with as many impurities of the soil as it could carry along with it in its downward course; and as it is a primary object with drainers to prevent impurities getting into the ducts, where in time they might accumulate, the only way to prevent such a mischance is to return the clayey subsoil into the drain, where it will again soon consolidate, and retard the direct gravity of the rain; as has been found when mud deposited among the stones of a drain has proved as impervious to water, and formed as favourable a soil for the growth of sub-aquatic plants, as a naturally impervious subsoil. A disposition, however, has been exhibited by some drainers to carry the prevention of water through the returned earth to the duct rather too far, by surrounding even pipe-tiles with the strongest clay afforded by the drain, in a puddled state, and tramping it in. Could this puddled clay be constantly kept in a moist state, it would resist the passage of the water, and prevent it entering the pipes at all; and I can conceive a pipe-tile so luted with wet clay as to be as hermetically sealed by it as the porous nature of the tile will admit. But it is not possible to retain the clay always in a moist state, as the portion immediately above the pipe will be drained by it, become cracked, and the cracks will permit the water to enter the tile *from above*. It being thus impossible to prevent water entering a tile at the bottom of a drain, it seems to be a matter of indifference in what state and with what sort of earth the drain should be filled. Fine sand, however, is a very unfit substance to cover tiles with, for it will certainly

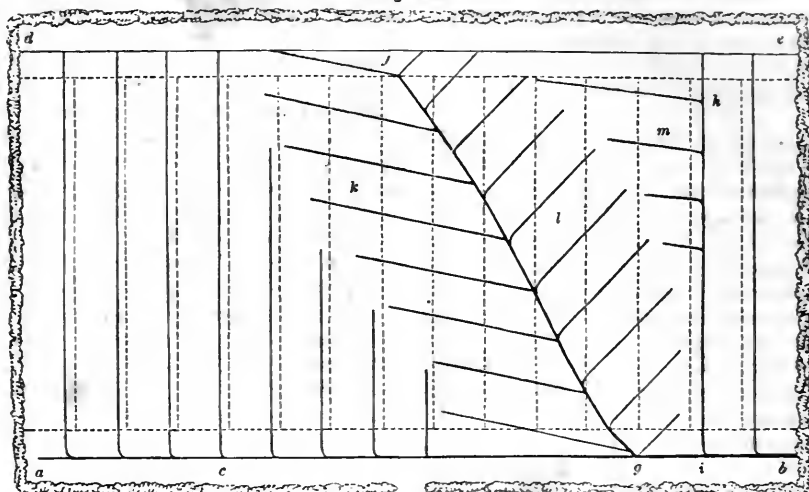
insinuate itself into every crevice through which water passes. The tiles in some drains in Dalmeny Park, belonging to the Earl of Rosebery, were covered with sea-sand and gravel; and the sand soon choked up the tiles and had to be removed, and the tiles re-laid in different materials. Perhaps it would be better to keep the soluble portion of the soil as far from the ducts of a drain as possible, and while thus rejecting the upper mould for a *commencement* to the filling, the subsoil might be returned into the drain in any order or state it may happen to be. The earth should not be returned into the drains too soon, but time allowed to the subsoil to crack above the tiles, which it will soon do in dry weather, and they will operate the sooner as a drain after the earth has been filled in; but in wet weather, the rain will wash down the earth into the drains, if they are left long open. So this particular of practice must be guided by the state of the weather.

5851. A general idea of the arrangement of thorough drains may be gained by a ground-plan of a field so drained, represented in fig. 517, where *a b* is the *main-drain* formed in the lowest head-ridge; and when the surface is uniform, the drains run into it parallel to one another from the top to the bottom of the field, as those from *a* to *c*, connected as they should be at the top with the drain *d e* running along the upper head-ridge. But with inequalities in the ground, an irregular surface cannot be drained in this manner, and must be provided with *sub-main drains*, such as *g f* and *i h*, which are each connected with a system of drains differing in character; *g f* having a large double set of drains, *k* and *l*, connected with it, and *i h* only one set, *m*, connected with it. The sub-main, *g f*, is supposed to run up the lowest part of a pretty deep hollow in the ground, and the drains, from *k* and *l*, on either side of it, are made to run down the faces of the acclivities, as nearly at right angles to the sub-main as the nature of the inclination of the ground will allow, so as always to assist the natural tendency of the water in finding its way to the hollow. There is also a supposed fall of the ground from the height above *l* towards *h*, which causes the drains at *m* to run down and fall into what would be a common drain,

h i , were it not, from this circumstance, obliged to be converted into a sub-main. The sub-main, g f , should be made larger than the main drain, a b , above g , as it

has more to do; but the sub-main, i h , should be made as small, and not larger than a common drain from the top of the field, until it reaches the point h , where

Fig. 517.



GROUND-PLAN OF A THOROUGH-DRAINED FIELD.

the collateral drains begin to join it. The main drain should be made larger below g to i , and still larger from i to b , towards its outlet, than any of the sub-main drains, as it has there most to do. It will be observed, that all the *common drains* from a to c , and at l and m , have their ends curved, those at k not requiring that form, because they enter obliquely into the main, from the slope of the ground. The dotted lines give the breadth of the upper and lower head-ridges, and the position of the open furrows of the ridges of the field; and it will be observed that the drains are not made in the open furrows—that is, the black lines are not in conjunction with the dotted. This is done with the view of not confounding the open furrows and drains in the figure; but it is a plan which may be practised with propriety, as the absorption of the water towards the drains should be effected from the subsoil as far as it is porous, and not directly from the open furrows. Such a ground-plan of a drained field enables the farmer to go directly to the spot in case of a stoppage occurring in any drain.

draining is to be executed; and the cost per acre depends moreover on the number of drains made in that extent of area. Tiles cost generally about 20s. per thousand, and soles are always half the price of the tiles. Pipe-tiles cost from 12s. to 22s. per thousand, according to their length and bore—the length varying from 12 to 15 inches, and the bore from 1 to 2½ inches. Main-drain pipe-tiles vary in the same proportion. The want of confidence in pipes is wearing away, so that they are now manufactured to the largest extent at the tile-works. Pipe-tiles are now always made with machines, and Ainslie's seem to be preferred to any other. I have seen it stated that machines thrust pieces of clay into the pipes in the manufacture, whereas the pieces found in some and not in all of the pipes consist of the pieces of clay which were put under their ends by the tile-burner, to make them stand in the most proper posture in the kiln. These pieces should be, and are easily, removed from the pipes before being laid in the drain. I think it unnecessary to give the cost per acre for draining, as it depends entirely upon particulars which are apt to fluctuate; but it is necessary to give the cost of certain particulars of expense which must be incurred in draining, over and

5852. The cost of draining with tiles depends on the price of labour and of tiles in the district of the country where the

above that of tiles and the cutting These particulars are furnished by Mr George Bell, Woodhouselee, Dumfriesshire, who drained his entire farm from 1837 to 1847, and they are as follows:—

Carriage of 38,000 common tiles, at 3s. 4d. per 1000,	£6 6 8
Carriage of 1,557 main tiles, at 5s. per 1000,	0 7 10
31 days' work of man and horse laying down tiles, at 5s. 6d. per day,	8 10 6
Work of women loading and unloading the carts,	2 3 0
30 days' work of a man laying soles and tiles,	2 5 0
30 days' work of a woman assisting him, at 8d. per day,	1 0 0
3 days' of plough-work, at 8s. per day,	1 4 0
Cost for 13 acres,	£21 17 0
.. 1 acre of drains 15 feet apart,	£1 13 7 $\frac{1}{4}$ *

So that £1, 13s. 7 $\frac{1}{4}$ d. per acre should be added to the cost of pipe-tile drains at 15 feet apart. The cost of loading and unloading, laying down and laying in pipe-tiles, is only half of that for tiles and soles; but how much less the entire particulars should cost I cannot distinctly specify, but should think that £1 per acre would be a fair allowance when using pipe-tiles. Mr Mechi gives this statement of the expense draining costs him: "My present cost of effectively draining an acre of strong clay land is as follows,—depth, 5 feet in the rising ground, averaging nearly 4 feet all over the field: distance, 40 feet between each drain—

64 rods of draining, at 6d. per rod of 54 yards,	£1 12 0
1100 inch pipes, 12 inches long, including 44 for breakage, at 12s. per 1000,	0 14 6
Cartage of pipes from kiln, 4 miles,	0 3 0
	£2 9 6

The cost may vary a few shillings per acre, according to the price of labour and pipes."† With the exception of the cartage of the tiles, this cost does not include all the particulars enumerated in Mr Bell's case, which should be included; still, if we add 17s. per acre for these, £3, 6s. 6d. is a small cost for draining an acre of land, if the drainage is really effectual.

5853. The physical benefits derivable from draining are numerous and important. The existence of moisture in the soil being easily detected by its injurious effects on the crops, the advantages derived from draining are also best indicated by its good effects upon them. On drained land, the straw of white crops shoots up steadily from a vigorous braird, strong,

long, and so stiff as not to be easily lodged with wind or rain. The grain is plump, large, bright-coloured, and thin-skinned. The crop ripens uniformly, is bulky and prolific, more quickly won for stacking in harvest, more easily thrashed, winnowed, and cleaned, and produces fewer small and light grains. The straw also makes better fodder for live stock. Clover grows rank, long, and juicy, and the flowers large and of bright colour. The hay wons easily, and weighs heavy for its bulk. Pasture-grass stools out in every direction, covering the ground with a thick sward, and produces flesh and milk of the finest quality. Turnips become large, plump, as if fully grown, juicy, and with a smooth and oily skin. Potatoes push out long and strong stems, with enlarged tubers, having skins easily peeled off, and their substance mealy when boiled. Live stock of every kind thrive, evince good temper, are easily fattened, and of fine quality. Land is less occupied with weeds, the increased luxuriance of all the crops checking their growth. Summer fallow is more easily cleaned, and much less work is required to put the land in proper order for the manure and seed; and all sorts of manures incorporate more quickly and thoroughly with the soil. Thorough-drained land is easily worked with all the common implements. Being all alike dry, its texture becomes equal, and, in consequence, the plough passes through it with uniform freedom; and even where pretty large stones interpose, the plough easily dislodges them; and moving in freer soil, it is able to raise a deeper furrow-slice, which on its part, though heavy, crumbles down and yields to the pressure and friction of the mould-board, into a friable, mellow, rich-looking mould. The harrows, instead of being held back at times, and starting forward, and oscillating sideways, swim along, raking the soil into a smooth surface, and entirely obliterating the horses' foot-marks. The roller compresses and renders the surface of the soil even, but leaves the part below in a mellow state for the roots of plants to expand in. All the implements are much easier drawn and held; and hence, all the operations are executed with less labour, and of course more economically and satisfactorily. All

* *Prize Essays of the Highland and Agricultural Society*, vol. xiii. p. 510.

† *Mechi's Experience in Drainage*, p. iv.—Preface.

these effects of draining I have observed in my own experience. Draining converts bad land—which is land resting in a natural state on a subsoil retaining surface-water until it stagnates—into good land—which is land resting in a natural state on a subsoil pervious to surface-water. Draining, in thus curtailing the limits of bad, necessarily extends those of good soil; and it makes rain our friend instead of our enemy—taking all its benefit, and avoiding all its injury. But draining is found to be beneficial not only to the soil itself—to the processes of labouring it—to the climate in reference to the crops—and to the growth of trees, but also to the health of the labouring population. Another physical benefit derived from draining, is the retaining of moisture at the bottom of the drains for the use of plants in very dry weather. Water is so retained, not in a stagnant state, for the surplus will pass off by the ducts of the drains, but in a fresh state, sufficient to moisten the subsoil and no more; which moisture is ready to be carried off by the ducts when fresh rain falls, and to be elevated to the surface in dry weather by the capillary force. Whenever drought desiccates the surface soil, and consequently forms innumerable fissures in it, the prominent points of soil readily absorb the dew and moisture from the air, while the capillary force brings the water from below to occupy the fissures.

5854. I have seen it stated by some writers that moisture rises through soils, not by capillarity but in vapour. But as it is commonly supposed that the diurnal variations of temperature disappear at the depth of 3 feet, I cannot conceive how vapour can arise from water of the mean temperature of 44° Fahrenheit at the bottom of a drain with such a force as to pass through several feet of soil.* Water is easily converted into vapour for some inches under the surface in summer—but at the depth of 3 feet and beyond, vaporisation must act with much diminished force. Mr Mechi seems to think that “the capillary attraction is stronger than the force of gravity,” and that the capillary powers of the soil are strongest at and near the

surface.† Conceiving these views to be not quite correct, and as considerable reliance may be placed on them in practice, they are worthy of inquiry. It is found that the height attained by fluids in tubes increases inversely as the diameters of the tubes, so that with a smaller diameter the greater height will be reached by any fluid in any tube. This being the case, capillarity bears no evident ratio to the density or specific gravity of the fluid. But as no tubes are found in the soil, we must regard the fissures caused by drainage as spaces between two surfaces; and in this case, the utmost elevation attained by the fluid is one-half of that which would have taken place in tubes having their diameters equal to the distance between the surfaces, and this is always inversely as the distances. It is thus equally evident that, between surfaces of fissures, capillarity bears no ratio to specific gravity.‡ The capillary force may seem stronger at the surface than lower down, because there the soil is driest by evaporation, and receives the moisture most readily; but inasmuch as the fissures are largest at the surface, there also the moisture will be less minutely diffused through the soil by the capillary attraction than lower down. Hence the capillary force cannot be destroyed by drainage; on the contrary, its sphere of action will be much extended by it, on account of the increase and even creation of fissures with surfaces.

5855. A still more important physical benefit to be derived from draining, is the equable supply of water for vegetation and the purposes of machinery. In undrained soil, the water remains constantly in it as in a filled sponge; and a fresh supply of rain, finding no room, runs off at the surface to the nearest stream, so that heavy falls of rain are succeeded by large inundations of turbid water. By drained soil, on the other hand, the rain is absorbed as it falls; and the deeper the drains are made, the larger the mass of earth is ready to absorb it. The water is thus retained in the ground for a time after it has fallen; in ordinary cases of rain perhaps 48 hours, and in heavy rains for 24 hours, before it passes off by the drains.

* *Transactions of the Royal Society of Edinburgh*, vol. xvi. p. 197.

† Mechi's *Experience in Drainage*, p. 9, 13.

‡ Bird's *Elements of Natural Philosophy*, p. 17, 18.

So that heavy rains are longer of appearing from drained than undrained land, and the drains continue longer to run. In heavy rains some of the water runs even off the drained surface in a turbid state, though in ordinary rains it leaves the ground in a clear state, having been filtered through the soil.

5856. The pecuniary profits derived from draining are not less remarkable than its physical benefits. The most palpable advantage is the *profit* it returns to the farmer. "I am clearly of opinion," says Mr North Dalrymple of Cleland, Lanarkshire, "that well-authenticated facts on economical draining, accompanied with details of the expenses, value of succeeding crops, and of the land before and after draining, will be the means of stimulating both landlords and tenants to pursue the most important, judicious, and *remunerating* of all land improvements. The statements below will prove the advantages of furrow-draining; and as to the *profits* to be derived from it, they are *great*, and a farmer has only to drain a 5-acre field to have ocular proof upon the point." Without entering into all the details of the statements given by Mr Dalrymple, it will suffice here to exhibit a few general results:—One field containing 54 Scotch acres, cost £303, 7s. to drain, or £5, 12s. per acre. The wheat off a part of it was sold for £11, and the turnips off the remainder for £25, 13s. 4d. per acre. The soil was a stiff chattery clay, and let in grass for 20s. per acre; but in 1836, after having been drained, it kept 5 Cheviot ewes, with their lambs, upon an acre. Another field of 18 acres cost £5, 9s. per acre to drain. The wheat off one part of it realised £13, the potatoes off another £15, 15s., and the turnips off the remainder £21 per acre. The land was formerly occupied with whins and rushes, and let for 12s. per acre; but when let for pasture, after being drained, Mr Dalrymple expected to get 50s. an acre for it. It may be mentioned, that the drains made by Mr Dalrymple were narrow ones, 30 inches in depth, filled 18 inches high with stones or scoriæ from a

furnace, and connected with main drains, 36 inches deep, furnished with tiles and soles. Mr James Howden, Wintonhill, near Tranent, in East Lothian, found from experience, that although drains should cost as much as £7 per acre, on damp heavy land, thorough-draining will repay from 15 to 20 per cent on the outlay.* These instances will suffice for Scotland. For England, on the estate of Teddisley Hay in Staffordshire, 467 acres, 9 poles, were drained at a cost of £1508, 17s. 4d.—that is, £3, 7s. 7d. per acre. The former rent was £254, 10s. 9d., and after the drainage it rose to £689, 3s. 1d., giving an increase of 28½ per cent on the outlay.† And for Ireland, on the estate of Castle Shane, county Monaghan, belonging to Edward Lucas, Esq., 57 acres, 2 roods, 13 poles, were thorough-drained for £269, 11s. 4d.—yielding an increased value of the land of 30 per cent.‡

5857. When drains are executed on stubble or lea ground, the first corn crop after draining is not sensibly increased in produce; but after the ground has been ploughed, properly wrought and manured, a very sensible increase of crop instantly takes place. Thus, in one instance adduced by Mr Bell, Woodhouselee, in 1839, the increase on oats was only 5 bushels on 2 acres, on the drained over the undrained land; and in the same year, 9 acres drained produced 258 bushels, and 6¾ acres undrained 192 bushels of good oats, being the same amount of produce from the undrained and the drained land. Those products are very much less than from drained land that has been effectually laboured.§

5858. But although the most remarkable instances of increase and profit are received from drained land, after it has been well wrought, it must not be imagined that the largest ratio of increase will be continued. Effectual draining makes the greatest impression at first on soils most injured by water, whether naturally good or bad; but, naturally, good land possesses more stamina than bad, and will maintain its superiority over bad, even though the

* *Quarterly Journal of Agriculture*, vol. viii. p. 319-21.

† *Journal of the Agricultural Society of England*, vol. ii. p. 279.

‡ *Transactions of the Agricultural Improvement Society of Ireland*, 1843, p. 39 and 44.

§ *Prize Essays of the Highland and Agricultural Society*, vol. xiii. p. 510-11.

latter should exert itself more for a few years after being drained. In corroboration of the remarks just expressed, I give a table constructed by Mr Thomson, Hangingside, Linlithgowshire, which presents the produce from an imperial acre of inferior and good land, before and after being thorough-drained; and the result is,

that the produce declined from both in the second rotation, and less from the good than the inferior soil; but still the inferior soil gave a return of more than 25 per cent from the corn, and 70 per cent from the grass; and such percentages from inferior soil ought to be regarded as highly remunerative:—

Kinds of Crops.	From inferior land.						From good land.											
	Before being drained.		After being drained.				Before being drained.		After being drained.									
			In the 1st rotation.		In the 2d rotation.				In the 1st rotation.		In the 2d rotation.							
	Bush.	Pks.	Bush.	Pks.	Bush.	Pks.	Bush.	Pks.	Bush.	Pks.	Bush.	Pks.						
Barley,	23	3	33	1	29	1½	27	3	38	0	36	2						
Oats,	35	2½	47	2½	44	1½	33	0	52	1½	50	0						
Grass by the acre, .	L. 1	S. 3	D. 9	L. 2	S. 11	D. 6	L. 1	S. 19	D. 8	L. 1	S. 11	D. 8½	L. 3	S. 19	D. 3	L. 3	S. 11	D. 4*

It would be of essential service to future drainers were those of the present day to ascertain the comparative amount of produce received from thorough-drained good and bad land, for a series of rotations of crops, that it may be accurately ascertained whether the smallest profit derived from thorough-draining bad land would repay the cost. I have no doubt it would.

5859. Drains are liable to obstructions by various growths and deposits which enter them. I have frequently met with the roots of the mare's-tail, *Equisetum palustre*, on cutting drains when they poured out a full run of water for some time; but on being emptied, and no longer receiving a supply of moisture, withered away. In a case mentioned by Sir Joseph Banks, the roots sent shoots upwards, "along the openings left for the passage of water,"† which proves that as much moisture had been left in the bog as supported the plant in life—in short, that the bog had been insufficiently drained; otherwise, on the privation of moisture, the vitality of the roots would have been destroyed. When the amphibious persicaria, *Polygonum amphibium*, finds its way into a drain, it chokes it up; and being a perennial, there is no chance of its dying out. Where this weed is suspected to exist, the drain should

be carefully taken up from the bottom, and every vestige of the plant removed. Some tile-drains made by Mr McLagan, younger of Pumpherston, Mid-Lothian, in October 1847, were choked up with some substance in March 1848, and in tracing its origin, it was only found in those drains which had received leakage from dungbills collected on a certain part of the field. The substance was gelatinous when wet, and like dried skin, and tough, when dry. It was pronounced an alga by Dr Greville, the *Conferea bombycina*, whose almost colourless or slightly greenish filaments pass rapidly into putrescence. The conclusion to be drawn from this case is, that the waste of liquid manures from the field dungbills should be prevented as completely as possible, not only because of the direct saving of valuable materials which would hereby be effected, but because of the outlay which will be prevented in remedying evils to which the matter that escapes may directly give rise.‡

5860. Mr Henry Dixon, Witham, says, "I have a curious evidence of the facility with which the roots of trees will destroy drains, if carelessly placed. The mass of fibres are the roots of a willow-tree, growing about 5 or 6 feet from the drain, which had been put down only twelve months,

* Prize Essays of the Highland and Agricultural Society, vol. xiii. p. 297-298.

† Communications to the Board of Agriculture, vol. ii. p. 349.

‡ Transactions of the Highland and Agricultural Society, July 1848, p. 296.

and the pipe from which I took it was a 4-inch socketed one."* The ash and horse-chestnut send strong fibred roots into drains; a remarkable instance of which I saw at New Hailes, near Edinburgh, in 1846, where a built conduit, of apparently 15 inches square, was in several parts completely choked up with the fibrous roots of those trees. It was with the view of avoiding such accidents that I have so frequently recommended every sort of drain to be placed at a distance from trees and hedges.

5861. Besides trees, other substances obstruct the passage of water in drains. Incrustations of lime stop drains, and are not unfrequent in limestone and chalk countries, where they are deposited some inches in thickness, and become quite hard. Common limestone is very difficult of solution in pure water, but when the water contains free carbonic acid, it is dissolved and converted into the bi-carbonate of limestone, which readily dissolves in water; but when, from any cause, the carbonic acid is again disengaged, the carbonate is immediately thrown down in thick incrustations.

5862. Depositions of oxide of iron also stop drains. Ochrey water is often seen issuing from drains in bogs. The water holds the protoxide of iron in solution, which when it meets the air freely is converted into the peroxide, which, being insoluble in water, is immediately thrown down in an ochrey deposit, that soon forms an obstruction to the water, as it is always associated with much vegetable matter.

5863. Fine sand occurring in quantity is apt to choke the ducts of drains. If it is permitted to accumulate above the outlets of main drains, in level bogs, it will dam back the water in all the drains unless the main-drains are lowest.

5864. Moles cause obstructions in drains by their workings in search of their natural food, the earth-worm. A remarkable instance of this was experienced by Mr Hay of Whiterigg, Roxburghshire, where he had used soles placed a few inches apart.†

5865. Draining being undertaken in a season when the workmen can scarcely keep themselves clean, and certainly not dry, any means to render their work more comfortable to them is deserving of attention. The Marquis of Westminster supplies his drainers with a dress, which it seems they readily take to. His words are, "We supply our labourers with a sort of leathern trousers, which protect the hips and legs from coming in contact with the wet clay. These leggings are used only by the man who digs the last narrow spit, and scoops out the lowest soil from the trench before fixing the pipes. In bending forwards, his shoulders also are brought into contact with the upper sides of the wet trench, to guard them from which a pair of leathern armlets are most useful. These armlets, as well as the leggings, are taken off and put on with perfect facility, are so far pliable as to create no impediments to the action of the labourers, fit sufficiently close not to rub against the sides of the trench, or make it crumble, and effectually keep out the wet for the entire day. They are easily rolled up and carried to and from the place of work." The leggings cost 20s., and the armlets 10s. the pair.‡ Wooden clogs are moreover a comfortable wear for men who have to work in any wet trench, (5607.)

5866. I have confined my observations entirely to tile draining, as it is the principal method now practised, to the exclusion even of stone draining, and still more so of the Elkington method. Still, cases may occur where large springs and collections of water may have to be conveyed away under ground in built conduits, and no method known is so well adapted for that purpose as the Elkington method; and small stones, such as the debris of rocks, may be so plentiful in some localities distant from tiles that stone drains might still be constructed there at less cost than with tiles. It seems therefore expedient to relate the peculiarities of both methods of draining.

5867. The coldest, the most injurious to useful plants, and the most permanent in its effects, is water from true springs, which continue to flow and retain their place in all seasons; and where these are copious, the most effectual way of removing them is by the Elkington method of draining. To take away such springs, and cause plants to derive their water from rain by means of furrow-drains, is therefore an excellent means

* *Journal of the Agricultural Society of England*, vol. v. p. 603.

† *Journal of Agriculture*, March 1848, p. 373.

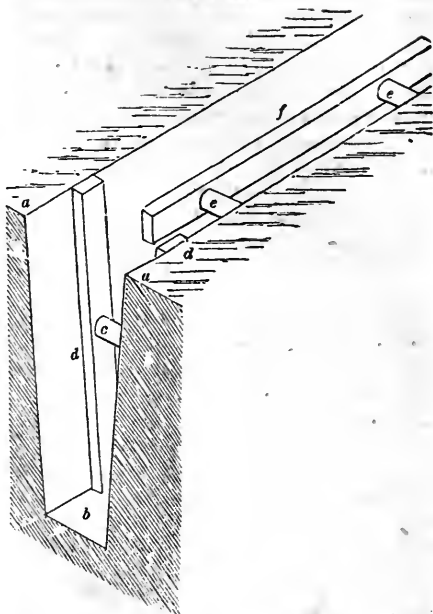
‡ *Journal of the Agricultural Society of England*, vol. x. p. 51.

of promoting the health of plants. Ponds and lakes of water cannot be drained by means of small furrow-drains, not only on account of their incapacity to carry away a large body of water, but also of the depth to which the drains suited for those purposes are required to be made so much beyond that of ordinary drains. The drainage of lakes, or any collection of water, is best effected by means of the Elkington system. We must, therefore, pay some attention to this method.

5868. The drain required to convey away the contents of a copious and deep spring, and of the waters of a lake, may have to be dug to the depth of from 6 to 10 or 15 feet, according to the lowest depth of the seat of the water to be removed. It is unnecessary to give directions for the digging of a deep drain, as it is conducted in the same manner as the drains we have already been considering, (5809.) But however deep the drain may be required, it is loss of time and money making it much wider than necessary for the work to be done in it. A simple calculation will at once show the difference of work to be done in digging a narrow and a wide drain. Suppose the drain is 6 feet deep, $2\frac{1}{2}$ feet wide at the top, and $1\frac{1}{2}$ foot at the bottom—these dimensions give an area of vertical section of 12 square feet, and in a rood of 6 yards in length a capacity of 216 cubic feet. If by inadvertence the workmen make it 3 feet wide at top, and 2 feet at bottom, the vertical section would be increased to 15 square feet, and the capacity to 270 cubic feet in every rood of 6 yards long, creating 54 more cubic feet in the rood, and giving either unnecessary labour to the workmen, or additional trouble to the employer to fill up such a chasm. However deep the drain should be, its width at the bottom should not exceed beyond giving room to the men to work.

5869. Should the drain prove very wet, and danger be apprehended of the sides falling in, the whole division engaged in for the time should be taken out to the bottom without stopping, in order to let the conduit be built into the drain as quickly as possible. Should the earth have a tendency to fall in before the bottom is reached, short thick planks should be provided, and placed against the loose parts of both sides of the drain in a perpendicular or horizontal position, according to the form of the loose earth, and there kept firm by short stobs, acting as props between the planks on both sides of the drain, as in fig. 518, where *a a* are the sides of the drain, *d d* planks placed perpendicularly against them, and kept in their places by the short prop *c*; or where it is necessary to have the planks placed horizontally, *f* and its opposite neighbour is so placed, and kept in their position by the props *e e*. When there is no tendency of the earth to fall in, the drain may be dug at once to half its depth. It is convenient to take off the upper half of a new division of the drain before digging to the bottom the division preceding it, in order to leave a stage upon which to hand down the stones for building the conduit in the preceding division which had been dug to the bottom.

Fig. 518.



THE POSITIONS OF PLANKS AND WEDGES TO PREVENT THE SIDES OF DRAINS FALLING IN.

5870. All large deep drains should be furnished with built conduits, to let the considerable body of water have a free passage in all circumstances. The building of the conduit should be contracted for as a separate operation from the cutting of the drains. If both are undertaken by the same party, the two sorts of work will be so carried on together to suit the convenience of the contractor, as to deceive the inspector by the work; whereas, if one sort of work is inspected and approved before another is allowed to be commenced, both will be executed in a satisfactory manner. The building of the conduit will cost from 1d. to 2d. per rood, according to the adaptation of the stones for the purpose. Flat handy stones can be built firmly and quickly, whereas round-shaped ones will require dressing with the hammer to bring them into proper shape, and much pinning to give them stability. The stones are furnished to the builder, and a labourer is usually provided to supply the stones as required. But circumstances may occur in which it will be more convenient to oblige the builder to quarry the stones, and supply himself with a labourer, the carriage of the stones only being furnished by the employer. A builder of dry-stone walls is better at building conduits for drains than a common mason, as he does not depend upon mortar, but upon pinnings of small stones to steady the building, (5704.)

5871. Should the ground be firm, the drain cut in summer, the length of the drain not very great, and the weather propitious, the conduit is most uniformly constructed after the drain has

been entirely cut out; and it is then most substantially and satisfactorily built from the top to the bottom of the drain, the uniform fall of the ground being then best adjusted. But in ground liable to fall in in winter, or when the weather cannot be depended upon for some days, or when the drain extends to a great length, the safest plan is to build the conduit immediately after the earth has been taken out to the bottom. The fall in flat ground is best preserved by building from the upper to the lower end of the division of the drain; and, where the fall is decided, it may be built in continuation from the preceding division.

5872. A convenient article in the building of the conduit is a plank of 6 inches in breadth, and from 6 to 9 feet in length, to place in the middle of the bottom of the drain, for a dry and firm footing to the builder. The plank is easily drawn on from length to length by a short rope-end or chain attached to each end by an iron staple.

5873. Even on ordinary subsoils of clay, the conduit should not be built without a stone sole, as water might carry away the material by degrees, and the flat stones thus laid form a permanent foundation for building the walls of the conduit upon. In every case where a *run* of water is expected in a drain, the bottom ought first to be laid with flat stones before the conduit is built.

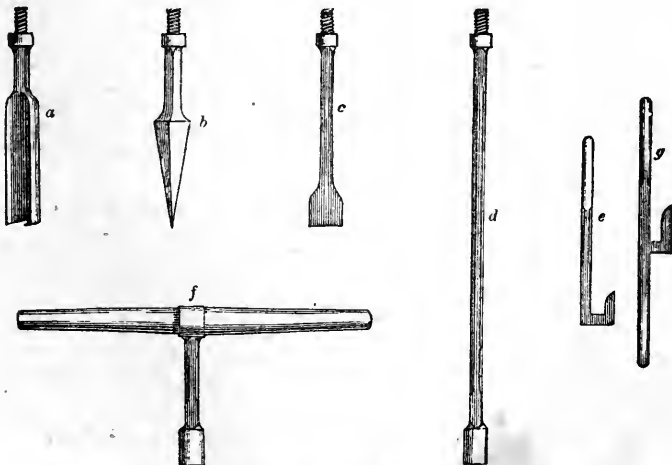
5874. Supposing the plank set down in the middle of the lower end of the cut, and there is plenty of fall, the stones are handed down to the builder from the surface, and it is most economical to employ a woman to do so. The conduit is from 9 to 12 inches in width, and from 15 to 18 inches in depth, according to the circumstances; and after the building is finished to the length of the plank, the plank is pulled by the ropes for another of its length, and length after length, until the entire drain, or the next division, as the case may be, is reached. The mouth of the con-

duit is formed of good and selected stones; and should be protected from vermin by close iron gratings. After the entire length of the conduit is built, it is covered with flat stones; but before laying down which, the sole of the conduit is cleared of all loose earth and stones, with a narrow hand draw-hoe, fig. 498. Immediately after this the builder lays the flat covers, 2 or 3 inches in thickness, receiving them from the labourer, from the adjoining half-cast-out division of the drain, and, working backwards, and giving them a hold of at least 3 inches upon each wall of the conduit. The open spaces between the meetings of the covers, which will probably not be square in the ends, should be covered with flat stones, and the space between the ends of the covers and the sides of the drain should be neatly packed with small stones to secure the covers in their places. To keep the finished conduit clear of all impediments, the builder shuts up its end with a firm wisp of straw, which, while permitting water to pass, seethes it of its earthy impurities.

5875. After the conduit has thus been built, the earth should be returned into the drain soon, in case rain fall and wash down its sides. The filling in of the first part of the earth of a deep drain is usually included in the contract made with the drainer, and is executed with the spade, as it is not safe for a horse to walk upon the edge of any drain until the earth is filled in nearly to the level of the ground. The whole of the earth may either be put in with the spade, or the remainder with the plough; but in any case a little mound of earth should be left immediately over the drain, to allow for subsidence to the original level of the ground. There will be much less earth left over the filling of a drain than would be imagined from seeing the quantity thrown out, and the space occupied by the stones; and in every case the mound soon subsides.

5876. But where it has been ascertained that

Fig. 519.



THE INSTRUMENTS FOR BORING THE SUBSTRATA OF DEEP DRAINS.

the strata under a collection of water is gravelly, and the water is retained in its place by an impervious stratum of clay over the gravel, the water will find a vent if a hole be formed through the clay into the gravel, which is most easily effected by means of boring-rods. The boring-irons are made to open a passage through various sorts of materials, such as impervious clay, thin rock and hard rock; and one or all of these substances may have to be penetrated ere an adequate passage be formed for the detained water to escape. Fig. 519 shows the various instruments used in boring, where the *auger*, *a*, is from 2½ to 3½ inches in diameter, and about 16 inches in length in the shell, the sides of which are brought pretty close together. It is used for drilling a hole in the ground, and bringing up the drilled earth. When harder substances than earth are met with, such as compact gravel or thin soft rock, a pyramidal *punch*, *b*, is used, to penetrate into and make an opening for the auger. When rock intervenes, then the *chisel* or *jumper*, *c*, is used to cut it through; the face of which should be of greater breadth than the diameter of the auger used afterwards. There are *rods* of iron, *d*, each three feet long, and 1 inch square, unless at the joints, which are 1½ inch in diameter, with a male screw at one end, and a female at the other, for screwing into any of the above instruments, or into one another, to make them as long as to allow the descent of any of the instruments into their working place. The short iron *key*, *e*, is used for screwing and unscrewing the rods from the instruments and from one another. A *cross handle* of wood, *f*, having a piece of rod attached to it, with a screw to fasten it to the top of the uppermost rod, is used for the purpose of wrenching round the rods and auger, and for lifting up and letting fall the rods and jumper, when these are used respectively. The long iron *key*, *g*, is used to support the rods and instruments as they are let down and taken up, while the rods are screwed on or off with the short *key*, *e*.

5877. Three men are as many as can conveniently work at the operation of boring a drain, and they use the instruments in this manner:—"Two men," says Mr Johnstone, "stand above, one on each side of the drain, who turn the auger round by means of the wooden handle; and when the auger is full of earth they draw it out, and the man in the bottom of the drain clears out the earth, assists in pulling it out, and directing it into the hole. The workmen should be cautious, in boring, not to go deeper at a time, without drawing, than the exact depth that will fill the shell of the auger; otherwise the earth, through which it is boring, after the shell is full, makes it more difficult to pull out. For this purpose, the exact length of the auger should be regularly marked on the rods from the bottom upward. Two flat boards, with a hole cut into the side of one of them, and laid alongside of one another over the drain, in time of boring, are very useful for directing the rods and going down perpendicularly, for keeping them steady in boring,

and for the men standing on when performing the operation."*

5878. The proper drainage of public cemeteries seems little attended to. It is well known that animal flesh decays more rapidly in dry gravel than in wet clay soils. Cemeteries ought, therefore, to be formed in dry soil; but where that is not accessible in localities, the ground ought to be thoroughly drained before the ground is made use of; and as graves are generally made not less than 6 or 8 feet deep, it is requisite that the drains ought to be below that depth. In most clay subsoils, veins of sand will be found traversing them before reaching that depth, so that the drains will not require to be very near one another to render the subsoil sufficiently dry. Such deep drains will require main-drain pipe-tiles to fill them; and where water seems copious, two should be placed side by side, as in fig. 526. In some cases conduits of stone may require to be built in some of the drains to carry off springs, as in the Elkington method (5870.)

5879. Small drains to be filled with stones are cut in the same manner as for tiles (5831,) only that stones are allowed more room in the bottom of the drain than tiles are. To give the larger room, the common spade is more used than the narrow-pointed ones of tile drains. Whether stones are obtained from the surface of the land or the quarry, it is obviously an absurd practice to mix stones of different sizes in a drain, as they can never assort; and it is positively injurious to the functions of a drain nearly to fill up the bottom of it with a large stone, where it is sure to intercept water and make a dam. Large land-stones should therefore be broken into small pieces. Stones broken in the quarry are always angular, and in so far are objectionable in shape, because on fitting together, face to face, they become a more compact body than round stones possibly can. No doubt, the ordinary pressure of a body of earth from 2 to 3 feet deep cannot squeeze small broken stones together so as entirely to compress the spaces between them; but gravity, continually acting on loose stones, will in time press them nearer; and heavy work upon the surface, and the subsidence of water through the earth, assist by their action to produce a similar result; and we all know that macadamisation makes a much more compact road than did the old-fashioned round stones.

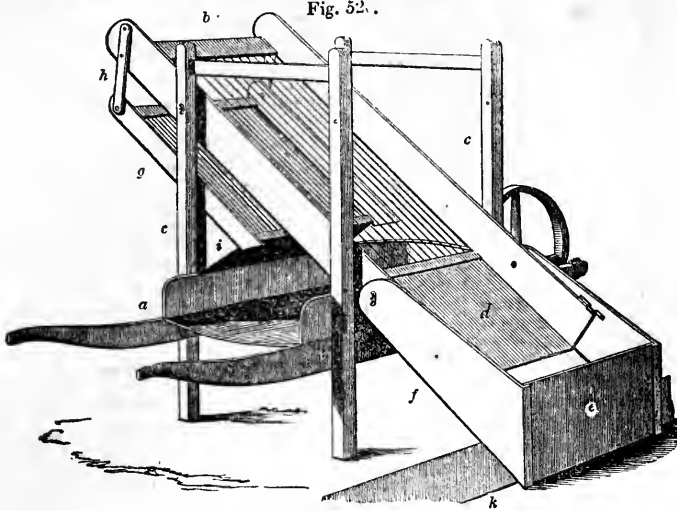
5880. Stones should never be broken at the side of the drain. I agree with the late Mr Stirling when he says that—"I prefer breaking stones in a *bin*. It is more easy to check the size, and it is done cheaper, as otherwise each heap has to be begun on the sward, and many of the stones are forced into the ground, which adds to the difficulty of lifting them. There will be a saving in carting the stones large, but it will be fully balanced by this disadvantage. I would deprecate of all practices that of breaking the stones in the field, and filling by the chain.

* Johnstone's *Elkington's Mode of Draining*, p. 111, 8vo edition.

This may be contracted for at a low rate, but it is easy to guess how the contractor makes wages."*

5881. I am acquainted with no drainer who

has bestowed so much pains on the breaking, preparing, and putting stones into drains as Mr Robertson, Ladyrigg, Roxburghshire. I shall describe his implements and method of preparing quarried stones. A portable screen or



THE DRAIN STONE-HARP OR SCREEN.

harp for riddling and depositing the stones, is seen in fig. 520, and it consists of a wheelbarrow *a*, on each side of which are raised two upright posts, *c c*, to the height of 3 feet above the barrow. Upon two of these posts is suspended a screen *b*, the lower end of which rests upon the side of the barrow. The screen is furnished with stout wires $1\frac{1}{2}$ apart. To the lower end of the screen is affixed a spout *d*, and at about 10 inches from the lower extremity of the spout is attached a board *e*, by means of two broad arms *f*. Another screen *g*, of one-half the length, and having the wires about half an inch apart, is hung parallel to, and about 10 inches below the larger one, *b*, by means of a small iron bar *h*, from both sides of the upper end of the larger screen; and its lower end rests upon the side of the barrow at *i*, sloping outwards from the opposite side to that of the spout *d*.

5882. The stones are put into the drain in this manner. All the earth should at first have been put on one side of the drain. The barrow-screen, fig. 520, is placed on the other side, so that the board *e*, attached to the lower end of the spout *d*, shall just reach the opposite side of the drain *k*. The cart, with a load of broken stones from the bin, is brought a little in advance of the barrow, and the carter, on removing the tail-board belonging to the cart, shovels the stones out of it with a frying-pan shovel, fig. 233, and throws each shovelful over the top of the screen *b*; but in doing this, he takes care not to throw

them over the screen with force, as they will not

Fig. 521.



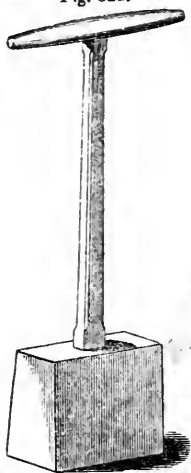
THE DRAIN STONE-RAKE.

alight sooner than half-way down the wires, where their efficient screening will be impaired. The proper method is to rest the shovel upon the top of the screen, which part should be protected with plate-iron, and merely give its handle a slight turn, when the stones will be released; the larger ones, rolling down, strike against the board *e*, and drop into the middle of the drain, without disturbing the earth on either side. The smaller stones, at the same time, pass through the upper screen *b*, and falling upon the lower one *g*, roll into the barrow at *i*; whilst the rubbish in passing through the lower screen *g*, falls upon the ground on the outside of the barrow.

5883. One man takes charge of the filling of the drain. His duties are to move the barrow-screen, fig. 520, forward along its side as the larger stones are filled to the required height; to level them with the iron rake, fig. 521; to take the smaller stones from the barrow with the frying-pan shovel, fig. 233, spread them regularly over the top of the

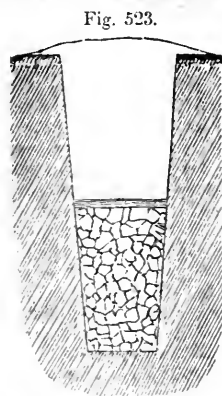
* *Prize Essays of the Highland and Agricultural Society*, vol. xii. p. 10.

larger, and ram them down with the beater, fig. 522, so as to form a close and level surface through which no earth may pass. When the stones are broken in the quarry, to pass through a ring, 4 inches in diameter, one-fourth will be as small as to pass through the wires of the upper screen *b*, fig. 520, and which is sufficient to give the top of the drain a covering of 2 or 3 inches deep, on being beaten closely down, in lieu of straw or turf.



THE DRAIN STONE-BEATER.

5834. A drain completed in this manner with stones may be seen in fig. 523, which represents one 36 inches deep, 9 inches wide at bottom, 12 inches at the top of the stones, and the stones 18 inches deep. These dimensions give 23½ cubic feet per rood of 6 yards. I am partial to the breadth of the common spade as a gauge for the width of the bottom of a drain to be filled entirely with loose stones, because it affords abundance of room for a durable stony filter, which 7 inches can scarcely accommodate, and much less 5 inches, when stones are broken to 4 inches in diameter.

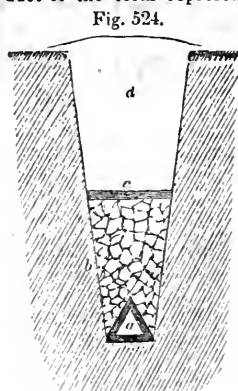


A SMALL DRAIN FILLED WITH BROKEN STONES.

5835. Mr Robertson's experience as to the time required for putting the stones into the drains is, that, in drains 33 inches deep, 7 inches wide at bottom, 15 inches filled with stones, and 9 inches wide at the top of the stones—the contents being 15 cubic feet per rood of 6 yards—supposing that a set of carts, driven by boys or women, are able to keep one man employed in unloading them, and another man in taking charge of the screen barrow, from 60 to 70 roods may be filled in a summer day of 10 hours; which amount of work gives from 3½ to 3¾ cubic yards per hour. These data are derived from large pieces of work, such as Mr Robertson contracted for in 1840, for the execution of 4,000 roods, the filling having commenced on the 1st July, and was completed on the 12th August. Two sets of carts

and two screens were employed, and the contractors had some stones ready, and part of the drains were half-executed by the 1st July. When the filling commenced, 66 roods were finished every day, comprising a length of drain of nearly 400 yards; and as the weather proved unfavourable for the work, only 3300 roods, instead of 4000, were executed under the contract, in doing which about 2000 cubic yards of stones were buried.* A drain of the dimensions represented in fig. 523 will require a longer time to fill.

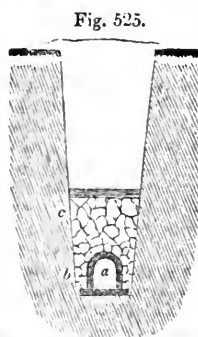
5886. I think a duct at the bottom, to convey the water the more quickly away, is desirable in every stone drain, although it should cause some trouble and expense. Where flat stones cannot be obtained, a sufficient duct may be made by placing a round shaped stone on each side of the drain, with a similar one upon them to act as a cover; but where flat stones are available, a duct of the form represented in fig. 524 should



THE TRIANGULAR COUPLED STONE DUCT.

be made, where *a*, a triangular duct, 6 inches in the side, is made of three stones—one laid flat on the ground, and two others set up as a triangle upon it. The sloping stones of the duct are held in their position by stones placed as wedges between them and the earth, and the drain is finished by 12 inches of broken stones, *b*, covered with small stones, *c*, and the earth, *d*, returned above them. The triangle encourages a deposition of sediment upon its flat sole, but prevents the descent of water under the sole to any dangerous extent. Having a flat bottom, this drain might easily be cast out with a width at top of only 15 inches.

5887. A more perfect form of duct is seen in



THE TILE AND STONE DRAIN.

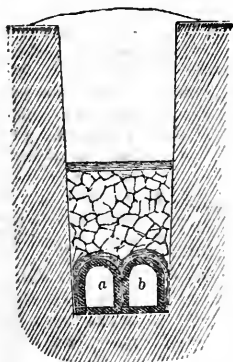
fig. 525, where *a* is a tile duct, either tile and sole or pipe-tile, the latter being the cheaper. In using tiles of any kind for ducts, in a stone drain, it is necessary to fill in the stones by hand with caution a little way above the tiles; and the remainder *b* might be put in with the barrow-screen, fig. 520, and covered on the top with small stones *c* beat down.

* Prize Essays of the Highland and Agricultural Society, vol. xiv. p. 37.

I consider this a perfect form of drain, inasmuch as its durability is secured by the well laid-in stones, its efficiency made certain by the superior tile-duct, while the area of the stony portion affords the permeable materials of the subsoil to part with their water with much freedom. Few farmers, however, will adopt this form of drain on account of its comparatively great expense. The Draining Commissioners have refused to sanction this form of drain.

5888. For a main drain, the expense might be incurred to secure a free conveyance of water from a large surface of stone drainage; and if one duct is deemed insufficient for the quantity of water to be conveyed, two tiles might be placed together abreast as *a* and *b* are shown placed in fig. 526. Instead of placing two tiles

Fig. 526.



TILE DOUBLE DUCT FOR A MAIN STONE DRAIN.

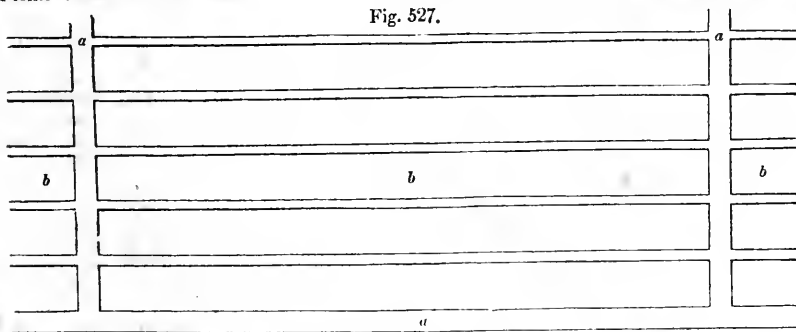
place one of them upon its back on the ground, and to set the other upon it, edge upon edge. Unless the tiles are provided with broad flanges, or a tile-sole be inserted between them, so as it shall lie upon the edges of the under tile, and form the sole for the upper one, it is evident that the upper one will always run the risk of slipping down into the under one.

5889. The cost of thorough-draining with stones, incurred by Mr Robertson, is as follows. The drains were placed from 30 to 36 feet apart, as the nature of the subsoil was favourable to drainage; and those average distances give 70 roods, of 6 yards, of drains to the imperial acre.

Opening drains 33 inches deep and 7 inches wide at bottom, at 5½d. per rood of 6 yards, for 70 roods . . .	£1 12 1
Preparing stones 4 inches diameter, at 4d. per ditto, . . .	1 3 4
Carriage of stones, at 4½d. per ditto, . . .	1 6 3½
Unloading carts and moving screen-barrow, at ¾d. per rood of 6 yards, . . .	0 4 4½
Filling in earth, at ¾d. per ditto, . . .	0 1 5½
Extra expense in the main drains, . . .	0 10 0
Per acre of 70 roods, . . .	£4 17 6½
Or per rood of 6 yards, . . .	0 1 4½*

5890. An important method of draining is that of *bogs*, which is executed in a different manner from tile or stone draining. I have seen extensive and successful cases of drying bogs in Ireland, by ordinary drains, especially of Carrick Bog, in the county of Meath, by Mr Featherstone of Castle Rattan; and as I consider his plan an excellent one, I shall describe it. The plan consists of dividing the bog into divisions of 60 yards in breadth, by open ditches of 4 feet in depth and 4 feet wide at top, allowance being thus made for the sliding in of the sides and subsidence of the moss by drying, which cause considerable diminution in the dimensions of the drains. The open ditches are connected by parallel drains at right angles, 3 feet 3 inches in depth and 18 inches in width. Fig. 527 is a plan of these drains, where *a* are the large ditches and *b* the small drains. The ditch *a* at the bottom, next the dry land, takes away the water to a river. The fall in the ditches and drains is obtained from the natural upheaving of

Fig. 527.



A PLAN FOR DRAINING BOGS AS PRACTISED IN IRELAND.

the moss at its centre above the level of the adjacent ground, and this peculiarity causes all the drainage water of such bogs to flow towards the land. This bog constitutes a part of the great Bog of Allen, which covers many thousands of acres. The moss is of great depth, and very wet and soft, and most probably floats upon the surface of a large lake.

5891. Besides the inclination of its surface—which much facilitates its drainage—this bog is

conveniently situated for its improvement after draining in the vicinity of extensive knolls of limestone gravel. This gravel seems to be a peculiar feature in the geology of Ireland, and appears as a gift of nature in those parts where bogs abound, as if to provide a ready means of converting their dried vegetable surface into useful earthy mould. When spread in a comparatively thin layer upon the drained moss, it soon converts it into an arable soil fit to carry in abundance every species of produce.

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 43.

5892. The small drains *b* are made in this manner. A garden line is stretched at right angles from one open ditch *a*, to another *a*, 60 yards. The upper rough turf is cut in a perpendicular direction, along the line with the edging-iron, fig. 528.

Fig. 528.



THE EDGING-IRON.

5893. At the end of that time the edging-iron, fig. 528, is employed by one man cutting down the sides of the drain in a perpendicular direction 2 feet 3 inches deep; while another man uses the square-mouthed shovel, fig. 83, to cut the moss into large square peats; which being wet, and situate much below the hand, cannot be thrown out with the shovel, but are taken hold of by a third man, with the small three-pronged graip, fig. 218, and thrown upon the surface, where their square form is regained by a few strokes with the back of the shovel, and then left to dry and harden. The work is again left for two months more, for the water to drain off, and the moss to subside still further.

5894. A new spade, which I have named here as the "horizontal spade," fig. 529, because it

Fig. 529.



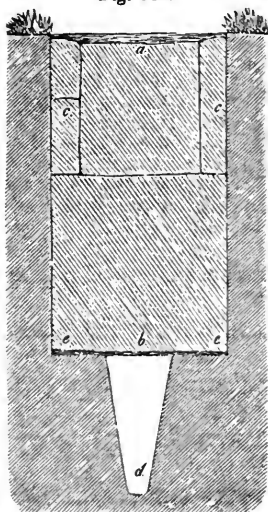
THE HORIZONTAL SPADE.

works in a horizontal direction, has lately been introduced in bog-draining, to cut the under parts of the peats and turfs in making these drains, and assist in casting them out, instead of the small three-pronged graip, fig. 218. In bogs, where footing is found for the workmen, or for

cutting the under part of the upper turf, this instrument is really useful; but in deep bogs, in the drains of which no man can be supported, such a spade is of no use in cutting out the second and lowest turfs, which are too much below the hand of a man standing upon the surface. The three-pronged graip is the only tool he can most conveniently use in such a case.

5895. In the course of the four months, the moss subsides about 1 foot, and the turfs and peats become firm. After the two spits of the shovel have been thrown out, the edging-iron is again employed by one man to cut down both sides of the drain to the depth of about 1 foot, leaving a shoulder 5 inches broad on each side. The pushing-scoop, fig. 509, is then employed by another man to cut the moss below and across this last narrow spit, whilst a third man takes out the cut pieces with the small graip. The scoop is employed to polish the narrow bottom of the drain with a few shoves of its back, making a duct 1 foot deep below the shoulders. The filling of the drain is commenced after this last spit has been removed, and is conducted in this manner. The large turf *b*, fig. 530, taken out by

Fig. 530.



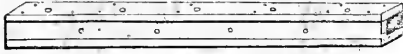
THE SHOULDERED BOG-DRAIN.

the second spit, being now dry, is lifted by the hand, and placed upon the shoulders *c c*. If this turf is replaced too tight in the drain, the moss will have a tendency to collapse from both sides, and choke up or diminish the open duct *d*. The large turf, *a*, first taken out, is then lifted by the hand, and put into the middle of the drain, as in the figure, with the grass face undermost, and the long narrow stripes of turf, *c c*, separated by the scoop from the bottom spit, along with any other broken pieces, are firmly packed, by means of the small graip, fig. 218, along both sides and top of the drain, so that the entire number of turfs just fill up the subsided drain to the top. It is not an uncommon practice to put the turf first taken out, upon the shoulders of the drain with the grass face undermost; but as the grass is soon converted into mould, and will fall into the duct, it is better to place the second turf upon the shoulders, being composed entirely of fibrous moss, unconvertible there into mould.

5896. When confidence is not placed in draining bogs by their own materials, and when larch

wood is plentiful, a species of tile may be made from it to answer the purpose of a rigid duct. Mr Scot of Craigmie, in the Stewartry of Kirkcudbright, has used tubes of larch as ducts in bog-draining, and found them to succeed. The larch-tube finished, represented in fig. 531, pre-

Fig. 531.



THE LARCH DRAIN-TUBE.

sents a square of 4 inches outside, with a clear water-way of 2 inches. The cost of these tubes, however, exceeds that of clay tiles and soles, and more so of pipe-tiles. Taking the cost of tiles and soles, of 15 inches in length, at 30s. per 1000, exclusive of carriage, their worth is 1½ farthing the lineal foot. A lineal foot of larch tube contains 1 superficial foot of timber at 1 inch thick, which costs, for carriage and sawing, 1 farthing; the fitting, boring, and pins, other 2 farthings; the timber, at 6d. the cubic foot, increases the cost 2 farthings more—altogether 5 farthings, making the tube more than three times dearer than tiles. And even with the cost of the timber thrown into the bargain, the tubes would still be double the price of tiles, including, in addition, carriage at 6s. 8d. per 1000; and, as a consequence, the price of larch-tubes will be more than double that of pipe-tiles.* Such tubes, therefore, would only be used in bog-draining, where the moss is too soft for tiles.

Fig. 532.



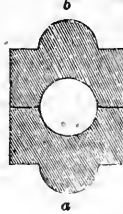
THE CALDERWOOD PEAT-TILE SPADE-TOOL.

5897. Tiles made of dried peats have been recommended for the drainage of land where peats are near, and tiles and stones distant. In case of such a locality requiring draining, a peat-tile may be made by a spade contrived by Mr Hugh Calderwood, bricklayer, Ayrshire. It consists of an iron cutting part, fig. 532, of a semi-cylindrical form, furnished with a flange on each edge, and a cutting tongue at the extremity of one of the flanges. It is provided with a cross-headed helve, which is inserted into a socket attached to the cutting part.

5898. The tile cut out of the peat by this spade has the appearance represented in fig. 533, where two separate tiles, *a* and *b*, are placed one above the other, leaving a circular opening in the centre between them. One man can cut

from 2000 to 3000 such tiles every day, which, after being thoroughly dried by the weather, are fit for use. In clayey subsoil they should be set in the drain as shown in the figure; but they may also be used singly in draining moss, by being set upon a plank of larch as a sole, as *b* rests upon *a*†

Fig. 533.

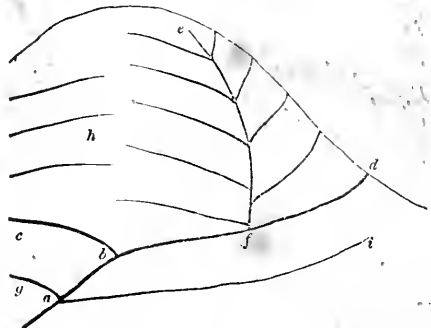


THE PEAT-TILE FOR DRAINS. 5899. In comparison to the expense of execution, perhaps no sort of draining has done so much good as *sheep-drains* on hill pasture, which have dried its surface, and made it sound for stock, where formerly disease prevailed to an alarming extent.

5900. The wet surface of pastoral hills composed of impervious clay may be dried on the principle of surface-draining, by cutting numerous transverse open drains across the face of the hills, and receiving the water from them in open ditches. Covered drains, however, when properly formed, are best adapted even for sheep pasture, as being not only secure from external damage, but permanent in their structure; and no sort of drain is better adapted for the pipe-tile. Such drains keep the surface unbroken; no manure from the pasture can be washed into them; the ground is rendered permanently dry; and I think they are much cheaper made than any form of drain at present known. Although I recommend covered drains in hill pasture, yet, as open ones are most frequently in use, it is necessary to describe the best forms of these.

5901. Open surface-drains in permanent pasture appear in plan as represented in fig. 534,

Fig. 534.



A PLAN OF SHEEP-DRAINS ON A HILL OF IMPERVIOUS SUBSOIL.

where the leader *e f* is cut the more nearly down the face of the hill the less steep the acclivity is, and the feeders are cut across the

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 99.

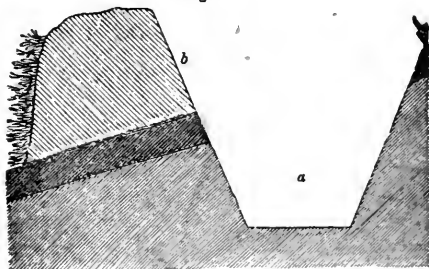
† *Quarterly Journal of Agriculture*, vol. vii. p. 247.

face nearly in parallel lines, into the leader. In this way, the water is entirely intercepted by the feeders in its passage down the hill. Where one leader enters another, the line of junction should never be at right angles, but at an acute angle with the line of the flow of water, as *ef* enters *db*; and where small drains enter a large, from opposite sides, they should do so at alternate points, as shown by the three drains above *f*, and not as the three pairs of drains above these towards *e*. The large main drain *cbd*, or the sub-main *g a i*, may be left open or covered. Should the sub form the line of separation between arable ground and permanent pasture, it may be left open, and serve as an assistant to the fence of the hill pasture; but, if the entire hill be under pasture, it may still be left open, as a catch-water drain. The ends of the drains at *h* show how they lie in reference to the drains from *e* to *f*.

5902. There are various ways of making drains in grass. One is to turn a furrow-slice down the hill with the plough, and trim the furrow afterwards with the spade. Where the grass is smooth and the soil pretty deep, this is an economical mode of making an open sheep drain. Every line should be previously marked off with poles when the plough is to be used. Such a drain would not cost a halfpenny per rood of 6 yards. But where the grass is rough and strong, and swampy places intervene, the plough is apt to choke, and come out of the ground, by the long grass accumulating between the coulter and beam, and make coarse work; while the horses are apt to strain themselves in the swampy ground, so that the risk would be considerable.

5903. A better, though more expensive mode, is to form them altogether with the spade. Let *a*, fig. 535, be a cut thrown out by the spade, 9

Fig. 535.

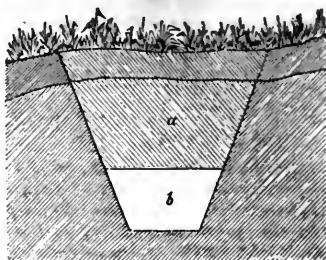


AN OPEN SHEEP-RAIN IN GRASS.

inches wide at bottom, 16 inches of a slope in the high side, and 10 on the low, with a width of 20 inches at top along the slope of the ground. A large thick turf *b* is removed by the spade, and laid with its grassy side down the slope, while the shovellings are thrown upon its top to finish the bank neatly. Such a drain catches all the water descending the surface between it and the drain above, and leads it to a main or sub-main drain. Such an open drain may be formed for about twopence per rood of 6 yards, provided many obstructions, such as brushwood and rank heather, do not encumber the surface.

5904. The drain, in fig. 536, is a covered sheep-drain. A cut is first made 6 inches wide at bottom, 16 inches deep, and 18 inches wide at

Fig. 536.



A COVERED SHEEP-RAIN IN GRASS.

top. The upper turf *a* is taken out whole across the cut, as deep and large as the spade can make it. Two men will take out such a turf better than one, with the assistance of the horizontal spade, fig. 529. It is laid for a time on its grassy face upon the higher side of the drain, and the earth pared from the other side with the spade, leaving the turf of a trapezoidal shape. While one man is doing this, the other is casting out with a narrow spade the bottom *b* of the drain; and the earth and shovellings are spread over the ground. The large turf *a* is then replaced in its natural position, and tramped down, leaving the open space *b* below it for the water to pass along. This is not so permanent a form of sheep-drain as the last, nor can it be so easily kept clear; and it is unsuited to pasture for cattle, as they would inevitably tramp the turf to the bottom of the drain, though it would be stronger were the turf *a* to rest on two shoulders as *b* does on *c e* in fig. 530. As made thus, it also affords an open space for moles to run along; and when any obstruction by them or other burrowing animals occurs, the part obstructed cannot be detected until the water is seen to overflow the lower side of the drain, where the turfs must be raised, and the obstruction removed. It forms, however, a neat drain, possessing the advantage of retaining the surface whole where sheep alone are grazed; but it could not be formed for less than fourpence per rood of 6 yards; and when it is determined to expend so much in making sheep-drains, it would be better to employ pipe-tiles at once, which would require a comparatively narrow cut. The pipe-drains could be made for little more than the original cost of the pipes, with carriage.

5905. It is surprising how little desire seems to be evinced by landed proprietors, to prepare the ground by draining for the reception of plantations. The fencing of young plantations is scrupulously attended to, and very properly, because young trees cannot defend themselves against the depredations of man and beast; but it is strange that it never occurs to the planter, that young trees are as little able to defend themselves against the chilling and suffocating influence of water about their roots, as their stems and tops can withstand the gnawings and

croppings of animals. The deleterious effects of water in the case of every large plantation that does not form an important portion of a domain may be explained—in the freezing of the ground in winter in one mass around the roots of the trees, as long as they are young; in obstructing the sun's heat entering the soil, and finding its way to the roots, in the early part of every year; in preventing the passage of the air to the roots of the trees, the presence of air being essential to their good health; and the particular effects produced by all these causes may be witnessed in every tree becoming the victim of lichens and mosses, or other parasitic plants, or of being evidently stunted in its growth, or diseased in the interior of the trunk. The consequences are, the trees are a very long time of reaching to a state of usefulness as timber or shelter, and can never realise the price of those grown on dry soils. It is not enough to place young trees in ground that does not become a plashy swamp in the worst winter weather, because rough ground will retain as much moisture, in its vegetable covering and spongy mould, as will injure the roots of the young plants constantly remaining in it. No alternative is therefore left, but to drain the ground before it is converted into a plantation, if the planter desires his trees to attain maturity and usefulness; and the system of drainage suited for such ground is neither intricate nor expensive.

5906. Ground appropriated to the use of trees, should be drained by open drains upon the surface only, and not with covered drains of any kind; for the roots of the trees will direct their first efforts towards the conduits of covered drains, in search of moisture in the summer season, and their fibres will soon choke up the orifice of the conduits. Now, open drains upon the surface will be quite sufficient to remove all the water that would remain in a stagnant state in winter, and prove injurious to the roots; whilst they allow as much moisture to remain under the roots of the trees as proves beneficial to them in summer; and they are not required to be made so large or so deep as to be objected to on the score of expense.

5907. On laying out the drains on such ground, it is requisite to observe the form of the surface; and wherever a hollow trough occurs, with rising ground on both sides, there cut a *main drain* along the bottom of the hollow. This drain should at least be 3 feet in depth, and have a flat bottom of 1 foot in breadth, to allow the spade to pass easily along; it in scouring out at any time the earthy and vegetable matter that may have fallen into it; and its width should be $1\frac{1}{2}$ foot for every foot in depth—allowing the bottom to be 1 foot in width. Thus, for example, a main drain 3 feet in depth would be $4\frac{1}{2}$ feet in width; but having 1 foot width in the bottom, it should be $5\frac{1}{2}$ feet wide. The size of the main drain is of course regulated by the probable quantity of water it will have to convey away from the small drains which lead into it; and besides, main drains, and all other sorts, should be so formed as to be rather too capacious than too

confined, to contain all the water that will ever flow in them.

5908. The *small drains* should not be made along the fall of the ground, as in the case of covered drains in ordinary arable land drainage, because the large body of water which they at times will at once collect from the surface would then be apt to run holes into their sides and bottoms. They should, therefore, be placed with a slope across the inclination of the ground towards the main drains, at such an angle as just to preserve a brisk enough trot in the water to carry off sediment and leaves, but not to injure the sides and bottom. In clay soil, the slope may be made more inclined than in light soil. The small drains should not be made less than 20 inches in depth in clay soil, with a width, of course, of 30 inches, and with 9 inches at the bottom, making the entire width at the top 39 inches. And on light soils they should not be made less than 14 inches in depth, and 21 inches in width, with 9 inches at bottom, making the entire width 30 inches.

5909. Where slight hollows occur across the surface of a field of small drains, a sub-main drain should be inserted therein, having a communication with a main drain. These sub-main drains should be of less dimensions than main drains, but larger than the small drains, and of the same proportions as the other two kinds.

5910. The cost of the 14 inches in depth drain in light soil, requiring a little picking at the bottom, will be about 1 farthing per running yard; and that of the 20 inches deep drain in clay soil, with extra picking, will be 2 farthings per running yard. The cost of making the main and sub-main drains will be in proportion to the above prices, according to the quantity of picking earth thrown out and required in the respective kinds of soils mentioned. The cost of draining per acre will depend on the number of the drains, and the number is determined by the distances fixed on between the drains; and the distances between the drains depend on the quantity and frequency of the rain that falls in the particular locality. Perhaps I may state, as a guide between two extremes, that the drains need not be nearer in any place than 5 yards, nor be distant more than 40 yards; the distance being closer in clay than in light soils.

5911. *Quicksands* are troublesome to dry, when met with in drains. Here is a narrative of a successful method of draining them with tiles, by Mr William Linton, Sheriff Hutton, York: "When the first man has got a few feet from the end of the drain, the second commences taking out the bottom of it; and as soon as he has made way for the laying of stones or clay tiles, they are immediately laid by the tile-layer—first laying the bottoms quite close to each other, and upon them the tiles, leaving as little crevice as possible, and immediately covering them with about 4 inches of the most tenacious soil that can be procured. Clay would be used, but on account of its being in large hard lumps, it cannot

be made to bed sufficiently close to keep out the sand. Here I must notice that it is essentially necessary that the drains be cut 3 or 4 inches wider at the bottom than the width of the tile, so as to admit this strong soil down the sides to the very bottom. Much mischief is done by the sand getting in at the bottom part of the joinings of the tiles. Other materials have been used for keeping out the sand, but with bad effect. I prefer clay to anything else, when it can be got sufficiently loose and malleable, so as to bed quite close and firm, and leave no crevice.

After the clay or strong soil is well trodden in, and thrust down the sides of the tiles with a common spade, the sand thrown out in the making of the drain is then filled in, and is firmly beat down by treading, and sometimes by running a broad-wheeled cart upon it, in which is put a sufficient weight, in order that the covering of the drain may become as firm as any other part of the field. This is done to prevent the water from descending, or finding a channel to the tile in that direction, or it would be almost impossible to keep out the sand.

The pipe-tile having been of late introduced into this neighbourhood, I have commenced using them. The drains are cut, and every other part of the work performed, in the same way as when the common tiles are used. But on account of the land being but recently drained by them, my observations are not sufficiently matured to justify me in saying that they are in all respects equally good with the common tiles. I find it sometimes difficult to get them to fit close enough to each other, the ends not being quite straight, and some of them curved in the middle; therefore it is necessary to apply clay to most of the joinings. Of these running sands I have drained about 500 acres; and when the plan which has been stated here at large was adopted, which has generally been the case, the average cost per acre was about £5, 5s.; that is to say, 1500 tiles at 26s. per thousand; 3000 bottoms at 11s. per thousand; cutting, £1, 10s.; and incidental expenses, 3s.; total, £5, 5s.*

5912. Every one travelling by railroad may have observed, in many of the deeper cuttings, that the earth had split in large masses down the face towards the bottom; and, on examining the cause of these slips, it will invariably be found to arise from the action of water upon the subsoil. The subsoil so affected is clay, and it is so affected whether it be of a uniform texture or interstratified with veins of sand. If there were no clay, there would be no excess or retention of water, and of course no land-slips. Cuttings of railways may be regarded, therefore, as drains intersecting the substrata to the extent of their depth, and exposing to view the sections of the impervious matter upon which the water naturally travels towards the cutting, in precisely the same manner, but on a much larger scale, as the water is seen to issue from the intersected strata of the exploratory drains recommended to be made in every field before being drained, (5793.)

5913. As the clay which retains the water that does the mischief cannot be removed, the only expedient left is to remove the water, by conveying it away in channels, instead of allowing it to take its own course amongst the interstices of the clayey strata; and these channels may consist either of open conduits or covered drains.

5914. One method in which these channels are usually employed, in draining the face of railway cuttings, is to place them in a slanting direction down the face of the cutting, in numerous parallel lines, and, when they slant from opposite directions, are sometimes made to empty themselves in a common channel. Where the entire face of the cutting is a uniform mass of tenacious boulder-clay, and the open channels are made as deep as to be imbedded in it through the mould returned upon the surface of the cutting, this method may answer the purpose. In all such cases the channels, to be efficient, should be of large dimensions, and cut deep into the clay--one being cut near the top of the cutting, and sloped to the right and left from its highest point; and only another, perhaps, cut about midway across the face of the cutting, of the same form and size. The water would find its way from the surface into these channels more quickly, were the surface raised into the form of ridges; and as there is always a built drain at the bottom of the cutting, the ridges should be continued below the lowest channel to that drain. But such channels are usually made in the face of the cuttings, whether the clay is of uniform texture or otherwise; and the consequence is, that the water, in oozing through the sand-veins, in time carries down both clay and channels in land-slips as it did before.

5915. Another method of draining the cuttings consists in making covered drains of tiles, branching in different directions, in the places where the water is found to burst out to the day; and the success of this plan is as uncertain as the other, because the remedy, in both cases, is applied to remove the effect, not the cause of the evil.

5916. A recent attempt, I observe, has been made to drain the face of these cuttings by means of patented cast-iron pipes, which are so laid down as to convey all the water to the drain at the bottom of the cutting; but this plan seems to me to be founded on no better principle than that of the open channels or covered drains mentioned above, inasmuch as it temporises with the effect only, and does not grapple with the true cause of the evil.

5917. The draining of such cuttings, I think, ought to be conducted in a different manner from any of these. In fig. 537, let $a b$ be the face of a deep railway cutting, from 20 to 40 feet in depth, rising, as such cuttings usually do, 1 foot in $1\frac{1}{2}$ foot. The ground at the top of all cuttings, b , will be found to exist in one of three states, namely, sloping upwards from b to c ; or on a

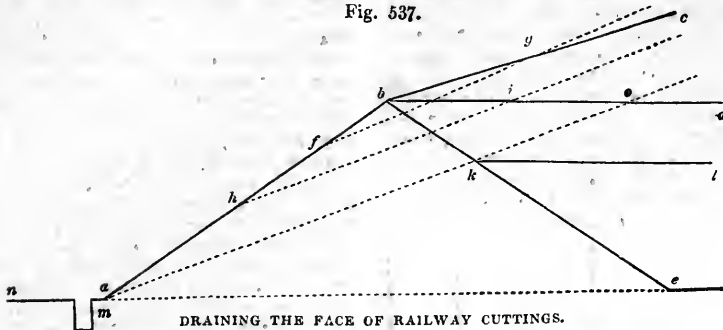
* *Journal of the Agricultural Society of England*, vol. vii. p. 117-18.

level from *b* to *d*; or sloping downwards, from *b* to *k*.

b to *c*, and the subsoil is of uniform clay, the water on the surface will run from *c* to *b*, and thence down the face of the cutting all the way, from *b* to *a*, washing away some of the soil in

5918. When the ground slopes upwards from

Fig. 537.



DRAINING THE FACE OF RAILWAY CUTTINGS.

its progress, leaving parallel ruts. But were an open channel formed in the face a little below *b*, and another about half-way down at *h*, and the face *b a* formed into upright ridges, it is evident that the open channels at *b* and *h* would intercept the water and carry it away, while the ridges would convey it faster into them than could the plain surface.

5919. When the subsoil is not uniform, but veined as from *f* to *g*, it is probable that part of the water will be absorbed by the ground at *g*, and find its way out at the face at *f*; in which case, a covered conduited drain a little way above *b*, as deep as to intersect the dotted line *g f*, would prevent the burst of water at *f* more effectually than any number of open channels or covered drains on the face at *f* could possibly do. If more than one stratum exists, as represented by *f g* and *h i*, a drain at *g*, deep enough to reach *i*, would prevent the lower burst at *h*, as well as the upper one at *f*.

5920. Where the ground is level from *b* to *d*, the water will not run off, but be absorbed, and find its way towards the cutting either by the vein *i h* or *o a*. Instead of using expedients to remove the burst of water at *h*, as is commonly done, a drain at *i* would prevent the burst at *h*; and if it were as deep as to reach the porous stratum *a o*, it would prevent the bursts both at *h* and *a*. When a burst is only seen at *a*, a drain at *o* will remove it. When the ground is of uniform clay, an open ditch above *b*, parallel down the face *b a*.

5921. On the ground sloping downwards, from *b* to *k*, no burst of water will appear on the face from *b* to *h*; and if the ground sloped as far as *e*, none could appear in the face of the deepest cutting. But as the ground commonly stretches from *k* to *l*, any fall of water from *b* to *k* upon a veined subsoil, would inevitably appear at *a*; and the only sure way of removing it is to make a drain at *k*, in impervious matter.

5922. It is clear, from these illustrations, that

the ordinary mode of draining the face of railway cuttings is erroneous in principle, and therefore proves ineffectual in practice. It may be that the sites of the drains at *g*, *o*, and *k* may be beyond the 100 yards reserved for the use of railway operations; but, to meet such cases, power ought to be taken in every bill to allow the drainage of cuttings to be effected. It may also be that some of the drains, as from *g* to *i*, and from *i* to *k*, may be required of inordinate depth, 8 or 10 feet, the cost of which should rather be incurred, and accomplish the drainage effectually, than waste time and labour in petty abortive superficial attempts.

5923. The railway is at *n*, and *m* is one of the conduited drains always constructed along the sides of a railway, and becomes the great means of keeping the railroad dry.

5924. I also observe that the hollows of railways are seldom drained before being filled up with the embankment, the weight of which pressing upon the wet soft ground causes it to slide aside, and the embankment to subside, when more earth must be brought to make up for the subsidence. Such hollows should always be drained with a main drain in the hollowest part, and small drains running into it from both sides, and filled with stones or tiles. As the embanking proceeds, its weight will squeeze the wet out into the drains, and no extraordinary subsidence will thereafter take place.

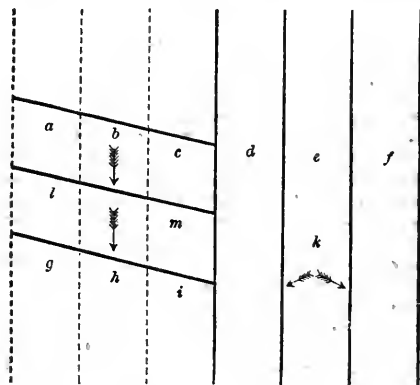
5925. These are all the cases of substantial draining likely to occur. Other minor modes, such as sod and wedge draining, are only modifications of covered sheep drains. (5904.) There are also plug and mole draining in strong tough clay subsoils; but tiles will supersede all these.

5926. It is improbable that drain-ploughs will ever come into competition with the hand, furnished with appropriate tools. I may mention that Messrs William Cadell, Sons, & Co., Crummond, exhibited excellent specimens of every tool for cutting field drains, as well as in hill

pastures, at the show of the Highland and Agricultural Society at Glasgow in August 1850.

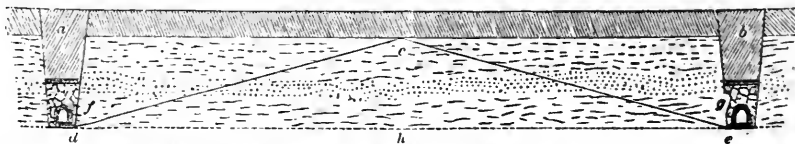
5927. There are a few considerations connected with draining which yet require our attention, as being necessary to the right understanding of the subject. Most drainers now believe that drains formed in the line of the inclination of the ground will drain the land more effectually than by drains traversing the face of the inclined ground, but some may still be found to question it as a fact. Without assuming more than one law of hydraulics, that water seeks the lowest level in all directions, I shall prove the accuracy of the opinion by referring to fig. 538, which represents

Fig. 538.



THE COMPARATIVE EFFICACY OF DRAINS ACROSS AND ALONG RIDGES ON A DECLIVITY.

Fig. 539.



THE DESCENT OF WATER ON A RIDGE INTO A DRAIN ON EACH SIDE.

its way from the surface of a ridge to the drain on either side along the imaginary inclined planes $c d$ and $e e$; but no force exists at c to cause it to take so decidedly a diagonal course, in counteraction to the force of gravity which carries it directly from e towards h . The fissures in drained retentive subsoil, having a perpendicular direction, conduct the water downwards with increased velocity to the assistance of gravity; and the assistance which the water finds in its way laterally into the drains d and e , from the centre force at h , is afforded by the fractures formed by shrinkage in the columnar masses of the subsoil.

5928. On the ridges $a b c$, fig. 538, on the other hand, the water will have to traverse, in the direction of the arrows b and h , the entire distance across the drains a and l or l and g , instead of half the distance on d, e, f ; for both sets of drains are supposed to be equidistant. So that the water should take double the time to reach the drains at a, l , and g , than at d, e , and f . Take the super-

two portions of a field supposed to have the same acclivity, and laid off in 6 equal ridges, a, b, c , and d, e, f , down the slope, three of which, a, b, c , having the drains oblique, and three, d, e, f , down the slope, the drains being equidistant. Now, when rain falls on, and is absorbed by the ridges, a, b, c, d, e, f , it naturally makes its way to the lowest level; and as the ground has the same declivity, it will reach the bottom of the drains sooner or later, as the circumstances presented by the two systems of drains accelerate or retard its motion. Let us see how these circumstances should operate:—On the ridges d, e, f , the water will at first take the course on each towards the open furrows, as indicated by the deflected arrows at k ; and as ground has seldom only one plane of declination, but more commonly one to the right hand, and another to the left, from a to f or from f to a , it follows that the lower side of a ridge thus situated will be sooner drained than the upper. But both sides will soon be drained, as may be seen by reference to fig. 539, where a and b are vertical sections of drains, and c 1 foot of mould, in which the rain is absorbed as fast as it falls upon the ridge, 15 feet broad, betwixt a and b . What is absorbed, on seeking the lowest level by gravity, will hasten at first perpendicularly towards the line $d e$; and, in doing so, the portions nearest the drains will find it easier to move towards the open ducts d and e than the close ground at h . In thus moving, the water will always remain at a higher level at h than at d or e , and, by its accumulation there, cause a constant lateral pressure towards d and e , and this the more powerfully the greater the supply of water from above. It is believed by some that water finds

facial view, and suppose that d, e, f , and a, l, g , are open furrows, the water will only have to move $7\frac{1}{2}$ feet, as indicated by the arrows at k , to reach the open furrows d, e , and f ; whereas on the ridges a, c, l, m , and g, i , it will have to move across the entire breadth of 15 feet, just double the distance of the other, before it can reach the open furrows, a, l, g .

5929. Trace the passage of the water under the surface, through the substrata. Mr Thomson, Hangingside, Linlithgowshire, drained 150 acres of land having an inclination varying from 1 in 10 to 1 in 30. Portions of 3 fields had drains cut in them in 1828, 1829, and 1830, in the oblique direction, and, finding them less successful than the rest of the fields, he put them in the direction of the slope. "In order," says he, "to ascertain the cause of these failures, a cut was made in the field first referred to, entering at a given point, and carrying forward a level to a considerable depth, when it was clearly

seen that the substrata, instead of taking in any degree the inclination of the surface, lay horizontally, as represented in fig. 540. It is there-

Fig. 540.



THE ORDINARY POSITION OF SUBSTRATA IN REFERENCE TO THE SURFACE SOIL.

fore obvious," he justly concludes, "that, in making drains *across* a sloping surface, unless they are put in at the precise point where the substrata crop out (and these are exceedingly irregular in point of thickness,) they may in a great measure prove nugatory; because, although one drain is near another, from the rise of the ground, none of them may reach the out-crop; whereas, in carrying a drain right up the direction of a slope, it is impossible to miss the out-crop of *every* substratum passed through."

5930. And although drains in the oblique direction should cut through a vein of sand as from *f* to *g*, fig. 539, and thereby carry off the water it contains, the drains along the inclination would also cut through the same vein and carry off the water as well. So that oblique drains present no advantage over those on the inclination, while they are attended with many disadvantages. This experiment of Mr Thomson's strongly supports my recommendation of making exploratory cuts before determining the depth and distance of drains, (5793.)

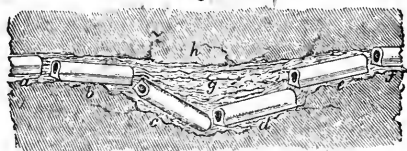
5931. The *minimum* depth which drains ought to have is easily ascertained by attending to the particulars of ordinary culture. A plough takes a depth of furrow of 7 or 8 inches; subsoiling and subsoil-trenching go 8 inches below that; a main-drain pipe-tile stands 6 inches high, and less than 3 inches ought not to be left between the top of the tile and the bottom line of the subsoil plough. Thus 25 inches are the least depth any drain ought to have, to preserve intact the materials with which it is filled.

5932. Although pipe-tiles are coming more into use every year, many farmers still prefer the common tile, and some yet believe that a sole is not requisite on hard clays. It is marvellous how such an opinion should be held by those having daily opportunities of observing the effects of the elements—for every farmer knows that clay is softened by rain at the surface of the ground; and when drains are formed in clay for no other purpose than to conduct water along their bottom, why should they doubt that water will soften clay as easily at the bottom as at the top of a drain? The question of economy interferes; for it is, I suspect, cheaper to use a tile alone than a tile and sole. But a pipe-tile is as cheap as a tile without a sole, so that the plea of economy can now urge no objection against them.

5933. Objections are made to pipe-tiles, that on being laid in the drains, they are not connected together like tiles that are laid to break band

upon soles. To meet this objection, collars and lobes have been contrived to connect them, all which are attended with trouble and expense. There can be no doubt that in the case of derangement taking place in a drain with tiles of any kind, from whatever cause, the pipe-tile is a safer means of continuing the flow of the water than a tile without a sole; for an arched tile is not a duct, but only a cover to a duct, whether a tile sole or the surface of the ground, when no soles are used—and whenever the ground or sole is deranged, so must the duct be. But a pipe-tile, however deranged, remains still a duct for the water; and although one pipe may be completely choked up with mud and rendered useless, the one before and behind will still operate as well as ever: no stoppage of water can take place beyond the undisturbed pipe on each side of the derangement. A figure will best illustrate this argument. It is obvious that no known species of force can act upon the tiles from below, to push them upwards; nor is it probable that any force can act upon them from above. The only way that we can imagine a derangement to take place is by the subsidence of the ground below them, or by an inordinate quantity of water. Now suppose that the pipe-tiles *b c*, *d e*, fig. 541, are displaced by the sink-

Fig. 541.



DISPLACEMENT OF PIPE-TILES IN A DRAIN.

ing of the ground below them, and that the earth above them *g* has fallen down. The water will continue to run from the pipe *f* as usual, and will occupy the interior of the pipes *c* and *d*, and partially that of *b* and *e*; and although the earth may have fallen in between their ends, the water will still find its way through *e* and *b*. The water will saturate the earth in *g* as high as until it reaches the level of the pipes *a* and *f*, which, remaining in their proper position, *a* will take it away, and it can rise no higher. It matters not whether pipes are upset or not as *c* is seen to be—it continues a duct as good as ever. Instead of pipes, had there been tiles without soles, they would instantly have been embedded in the soft earth, and rendered useless as covers to ducts; and even had soles been furnished, the displacement of them would have rendered them equally useless as ducts.

5934. It is not an uncommon impression that pipes, being close along their sides, cannot take in the water from the drain so quickly as a tile and sole. Whether they can do so as fast is of no consequence if it can be proved that ordinary pipe-tiles are sufficient to take away the largest quantity of rain that will probably ever fall in this country. I can prove this in a simple manner. Suppose that egg-shaped tiles of 2 inches wide and $2\frac{3}{4}$ inches in the bore are used, their cir-

cumference is 10 inches. These tiles cannot be placed *closer* to each other by the ends than an eighth of an inch apart, so the area comprised between two tiles is $1\frac{1}{4}$ square inch. Suppose that the drain is 200 yards in length, to furnish which 480 pipes of 15 inches in length are required. Now the joints between this number of pipe-tiles afford openings for water to enter them of exactly 600 square inches, equal to 4 square feet and 24 square inches. Does any one doubt that an opening of 4 square feet and upwards would easily contain all the water that could possibly come out of one drain of 200 yards long in the greatest rain that was ever remembered to have fallen in this country? It may be very true from this, that inch-bore pipe-tiles are sufficiently large for drainage, as the practice of some English drainers demonstrates; but I do not see the utility and safety of using the smallest bore—of applying the homœopathic principle to draining—when a much larger bore can be afforded for a comparatively less sum of money.

5935. The bulk of earth relieved of its surplus water is an effect I suspect but little regarded when the depths of drains are determined; and yet I conceive this to be the true expression of the work done, as a mere statement of the cost of drainage per acre of surface conveys but an imperfect idea of the substantial benefit conferred upon the land. Thus, taking the cost of 2 feet drains, in stiff clays, 24 feet apart, at £3, 4s. 3d. per acre; of 3 feet drains, in porous soils, 33½ feet asunder, at £2, 5s. 2d.; and of 4 feet drains, in soils of varied texture, 50 feet apart, at £2, 5s., the following results in cubic yards as to the depth, and in square yards as to the surface, drained for one penny, at the above mentioned prices, depths, and distances, will be obtained:—

Depth of the drains in feet.	Distance between the drains in feet.	Mass of soil drained per acre in cubic yards.	Mass of soil drained for 1d. per cubic yard.	Surface of soil drained for 1d. in square yards.
2	24	3226½	4.1	6.27
3	33½	4840	8.93	8.93
4	50	6153	12.00	8.96

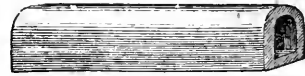
The results are, generally, that double the depth of drain has effect on about three times the cubical contents of the earth, and about half more in extent of surface; and, particularly, that 3 and 4 feet drains in depth dry about the same extent of surface, though the 4 feet drain dries one-half more of the ground in cubical contents.*

5936. The late Mr Smith recommended that, "in cases where time or capital are wanting to complete the drainage at once, each alternate drain may be executed in the first instance, and the remainder can be done the next time the field is to be broken up."† I would meet this recommendation in the words of the late Mr Stirling of Glenbervie, that "I think it a *great error* to make at first the half the number of drains required, with the intention of putting one between each at a future period. Let what is drained be done as thoroughly as the farmer's

exchequer will allow; the farm will be gone over in as short a time, and much more profitably." The reason Mr Stirling gives for holding this opinion is as practical as it is true; because "a tid—proper condition of the ground for harrowing—cannot be taken advantage of on the drained furrow until the other is dry, and the benefit of an extended period for performing the various operations of the farm is thus lost."‡ Every farmer who has studied the influence of soil is ready to allow that wet soil does more injury to the dry in its neighbourhood, than the dry does good to the wet. I would, therefore, under every circumstance of season and soil, prefer having the half of my farm thoroughly, to the whole of it only half drained. On visiting a friend in Dumfriesshire, when he was draining his land in halves, I recommended the full drainage at once. After a sufficient trial he followed my advice, and thanked me for it.

5937. A pipe-tile of an arch upon a flat sole, fig. 542, was introduced some years ago by Lord

Fig. 542.



A CONCRETE PIPE-TILE.

James Hay, of Seaton, Aberdeenshire. It was formed of *concrete*, composed of *good lime, sharp sand and gravel*, mixed in the proportion of 1 bushel of lime-shells to 2½ bushels of sand and 4 bushels of gravel, which, in swelling, gave 8 bushels of concrete that made 120 tiles. The concrete was run into moulds, in which it soon set firm enough to be placed on boards, and the tiles became in a short time, according to the state of the air, in a sufficiently indurated state to be used. One man, aided by perhaps 4 others to supply the materials, could make 5000 tiles a-day. When the quantity of boarding is taken into consideration, I have great doubts of this process affording a cheap tile; at all events, it can only be made in those localities where *sharp sand and gravel* are found in abundance—substances which cannot be carried to a distance but at great expense.

5938. Drainage has an unexpected effect upon the organic as well as the mineral matter of *peat*. The proportion of humic, ulmic, and other soluble acids taken up by alkali, and of resin extracted by alcohol from drained and undrained peat, dried at 212° Fahrenheit, were as follows:—

	Drained.	Undrained.
Wax and resin,	1.75	1.63
Humic and ulmic acids,	6.56	14.62
Humic, and insoluble undecayed vegetable matter,	78.18	47.15
Earthy matter, or ash,	13.51	36.60
	<hr/> 100.00	<hr/> 100.00

* *Journal of the Agricultural Society of England*, vol. v. p. 154-6.

† *Smith's Remarks on Thorough-Draining*, p. 17, 4th edition.

‡ *Price Essays of the Highland and Agricultural Society*, vol. xii. p. 102.

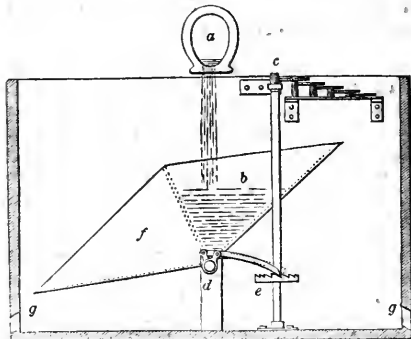
"The difference which the above numbers show to exist between these two peats is sufficiently striking," observes Professor Johnston; "and it would be both theoretically and practically interesting, were we certain that it prevailed generally between drained and undrained peats, and was not owing merely to specific or local causes. In the undrained peat there are $14\frac{1}{2}$ per cent of acid matter—of those black acids which are formed naturally by decaying vegetable matter—which dissolves in caustic potash and soda, and in the carbonate of these alkalis. But as the peat contains $36\frac{1}{2}$ per cent of mineral matter, the organic part contains 14.62 parts in $63\frac{1}{2}$, or 33 per cent. In other words, one-third of the vegetable matter of the undrained peat is in a state of humic and ulmic acids. The drained, again, contain 6.56 parts of these acids in 100 of the natural peat, or in 86.49 parts of its purely vegetable portion. This is equivalent to 7.5 parts in 100 of the organic matter; or, instead of $\frac{1}{3}$, the acid substances in the drained peat form only $\frac{1}{3}$ th of its organic portion. Supposing such a difference to be general, it indicates that the effect of removing the water by means of drains, and admitting the air, is to render the organic part of the peat insoluble, or to change the humic and ulmic acids into insoluble matter devoid of acid properties. This change is by no means an improbable one, and is consistent with the previous observations of Sprengel as to the alteration which the acids of peat undergo by exposure to the air. It is this acid matter in peat which preserves wood, the bodies of animals, and other substances embedded in it, from decay, and which proves noxious to the roots of plants. One of the immediate benefits resulting from the action of lime, when applied to peaty soils, is owing to its combining with these acids, and thus depriving them of their injurious action upon the crop sown or planted on peaty soils. If it be made clearly out, by further researches, that the usual effect of draining upon such soils is to change this acid matter, to deprive it of its acidity, and thus render it insoluble and un hurtful to plants, a very considerable light will be thrown upon this important point of the management and amelioration of our wet and boggy land of every kind."*

5939. A drawback against the advantages of draining may be founded on the quantity of matter, whether chemically dissolved or mechanically suspended, which the water takes out with it in its passage through the soil by the drains. After a large fall of rain, recent experiments have detected as much as 12 per cent of solid matter that had been carried off by drainage water, while spring-water contains about 8, and filtered water only 4, per cent. It is very probable that, through loose subsoil, a large fall of rain may carry with it a considerable proportion of earthy matter held in suspension, and a small proportion of saline matters; but in clay soils we have reason to believe, from the experiments of Professor Way, (5116,) that rain-water is able

to take away a very small quantity of alkaline salts. Even in the case referred to above, where the solid matter amounted to 12 per cent, the surface-water contained 2 per cent of potash and soda, while the drainage-water only indicated a tracing—showing that the subsoil had either been clayey, or that drainage-water does not take away the soluble ingredients of the soil in so large a quantity as might be apprehended. Were drains perfectly made, so as the water should go through them in a slow manner, the spoils it would be able to carry away from the soil would be of very small amount.†

5940. It would be as desirable to ascertain the quantity, as well as the quality, of the water discharged by drains at any given time. Mr Milne, of Milne-Graden in Berwickshire, has contrived a machine by which the discharge may be measured accurately enough for all practical purposes, of which fig. 543 is a view in section,

Fig. 543.



A DRAIN-WATER METER.

where a is the drain-mouth which supplies the water; b the vessel which receives the water; c an upright spindle, which carries a rack that sets in motion a series of graduated wheels and racks which mark the tenths, hundredths, and thousandths of gallons discharged in a specified time. When the vessel b becomes full of water, it descends towards the bottom of the box in which it is placed, by turning upon the axle d, in doing which it moves the ratchet-wheel e on the spindle c by means of a short lever, and discharges its water by the opening at g. When one half of the vessel b descends and empties its water, the other half, f, ascends to receive the water from the drain-mouth a, and, after being filled, descends again to its own side of the box, and empties its water by another opening g.

5941. Mr Milne placed a meter at the mouth of a main drain in connection with a system of drains of different depths, draining each 6 acres of ground; and after the meters had remained from June 1848 to April 1849, the following results were obtained:—

	Gallons per acre.	
At 3 feet deep and 15 feet distance,	35,711	
3½ " " " 30 " "	46,510	

* *Transactions of the Highland and Agricultural Society*, March 1848, p. 237.

† *Scottish Farmer*, 1850.

It appears that rather more water had been discharged from the $3\frac{1}{2}$ feet deep than the 3 feet deep drains, though the latter were twice as numerous as the former. In the parts of the field drained by the 3 feet drains, more water was left in the land, or went off by evaporation, and there was also less depth of soil to the drains. There was more straw grown on the land drained with the 3 feet drains, and most grain on that drained by the $3\frac{1}{2}$ feet drains. The grain grown on the latter was probably produced with greater dryness and warmth, as the larger quantity of rain they carried off would impart to the soil a greater amount of heat. The subsoil was pretty uniformly retentive throughout the field, and the upper soil was not perceptibly more open in one part than in another. So far, therefore, as these experiments had proceeded, they showed that, if drains were made $3\frac{1}{2}$ feet deep, only half the number will produce the same, and even a still better effect, than 3 feet drains. The expense of making the $3\frac{1}{2}$ feet deep drains, at 30 feet distance, was £4, 6s. 4d. per acre, and of the 3 feet deep ones, at 15 feet apart, £8, 12s. 4½d. per acre.

5942. From the careful experiments conducted by Mr Diekenson, the eminent paper-maker, at Abbot's Hall, near King's Langley, Hertfordshire, the average quantity of rain which falls there annually is 26.6 inches, more than the average fall on the east coast of Scotland, and 42½ per cent of it is filtered through the soil, amounting to 11.17 of the 26.6 inches.

5943. At one time it was a rather difficult matter to settle the proportion of the cost which the landlord and the tenant should each pay when draining was executed at their mutual expense. On cogitating on the subject, I came to the following conclusions:—Suppose a landlord determines on thorough-draining a farm, takes it into his own hands, and disburses every cost attending the operation. When his purpose has been attained, it is no more than reasonable in him to desire to receive back his disbursements, principal and interest, during the 19 years he is about to dispose of his farm to a tenant; for if the farm will not repay the expense of its improvement in the reasonable period of 19 years, little advantage will be derived from it. Now, a landlord will receive back all his disbursements, principal and interest, in a 19 years' lease, at 8 per cent on the money expended.

5944. Suppose, again, a tenant disbursed all the expense, he would be equally reasonable in expecting 8 per cent on his outlay during the lease.

5945. But the positions of landlord and tenant, on expending the same sum in draining a farm, are widely different. The tenant is not only entitled to receive the 8 per cent—that is, get back all his outlay—but he is also entitled to a profit for his personal trouble in undertaking the draining; which profit should be the same as commercial people generally expect on their outlays, which is now 10 per cent, and used to be

15 per cent. The tenant, therefore, should receive *at least* 18 per cent for his disbursements, while the landlord should be satisfied with *at most* 8 per cent for his. For, as regards the tenant, the 19 years is the longest period he can calculate upon to receive back his money, and his case is not made better though the lease should be renewed, as new conditions will be made as if he were a stranger—which are good reasons for his receiving 18 per cent on his outlay. But when a landlord effects improvements, he derives benefit from them for an indefinite period; and all he can expect in return is the common rate of interest he would receive were he to invest his money in any ordinary security, and which seldom exceeds 5 per cent. So that to induce him to undertake any trouble greater than receiving an annual payment of interest, some greater temptation than the ordinary rate of interest should be proffered to him; and although the farm to be drained is his own property, he cannot be expected to give himself the trouble to borrow money and pay the ordinary interest for it, or lay out his own money and receive in return no more than common interest. The interest of money fluctuating from $3\frac{1}{2}$ to 5 per cent, there is therefore nothing unreasonable in his receiving a greater rate than the ordinary one for the time being.

5946. Now, what is the conclusion that should be drawn from these premises? Clearly that the landlord should undertake the entire expense of draining upon himself; because his interest in the improvement is permanent—he has the strongest motives for executing it—his demands upon the land are moderate, amounting only to the usual rate of interest—and in disbursing a portion of his capital, a smaller portion of the capital of the country is placed in jeopardy than when the tenant undertakes to disburse the whole expense.

5947. In the preceding suppositions, either the landlord or the tenant is supposed to undertake the entire drainage; but when a mutual understanding exists betwixt them, its conditions should be based on the principle, that both parties should receive their respective rates of interest; namely, the landlord his 8 and the tenant his 13 per cent; nor should the tenant grudge his landlord his 8 per cent, or the landlord exact a greater rent than will enable the farm to repay the tenant, with ordinary skill, 18 per cent; and although both these rates are charged upon the land, they will not amount to a large annual exaction upon it. For example, suppose four-fifths, or £80 out of every £100, are expended by the landlord—and some landlords have willingly expended this proportion—he should receive £6, 8s. a year as his 8 per cent; and the tenant, to receive 18 per cent on his fifth, or £20, should have £3, 12s. a year, both sums together making 10 per cent on the whole outlay; which, if exacted as an annual tribute from the land, would only amount to 4s. an acre on land worth 40s.—a sum, it is obvious, which its thorough-drainage would easily repay.

5948. This question between landlord and

tenant has been much simplified by the terms of the Drainage Act, which empowers parties desirous of draining land to apply to the Treasury for a grant of money adequate to do the work, for which $6\frac{1}{2}$ per cent interest is payable for 22 years, when the entire debt is liquidated. The practice has settled down to the landlord giving the Treasury the security on his land for the repayment of the loan, while the tenant pays the $6\frac{1}{2}$ per cent. Few farmers refuse to pay the percentage, though others conceive it is too much for a tenant to pay. If he pays the $6\frac{1}{2}$ per cent for 19 years, the term of his lease, the tenant has nothing to complain of; for, had the farm been through-drained when he took it, he would have had to pay more rent for it than the $6\frac{1}{2}$ per cent would be; but if he be bound to pay the whole amount of the percentage of the 22 years in 19 years—which some landlords exact—then he is in a hardship; for when the lease expires in 19 years, the landlord relets the farm for other 19 years at the advanced rent of through-drained land, while he has only to pay the $6\frac{1}{2}$ per cent for three years.

ON IMPROVING WASTE LAND.

5949. Where the surface of the ground that has been drained is waste, it may require to be brought into cultivation by other means than the plough. When the ground consists of the site of an old plantation, it is impossible to bring it under the plough but by trenching it with the spade. The smallest root forms an inextricable obstacle to the plough; and the destruction in implements, injury to horses, and the time spent in removing the obstructions, cause more waste of money and time than trenching with the spade.

5950. In like manner, when it has been ascertained, by the sinking of pits, that the subsoil contains a large quantity of stones, of whatever size, though the ground has not been the site of a plantation, it should be trenched in preference to being ploughed. In ploughing *stony* ground, though free of other obstructions, the plough meets such opposition from large stones as constantly to stop its progress; and the shock not only endangers the implement, but injures the shoulders of the horses so much as, when frequently so stopped, they become timid whenever put to similar work; and even where the numerous stones are small, the plough cannot maintain its hold of the ground, and is easily and frequently thrown out, so that the ploughing is not only imperfectly exe-

cuted, but much time lost in remedying failures.

5951. Independently of tree-roots and numerous stones, the roots of brushwood—such as of hazel, alder, birch, broom, and whin—render ploughing difficult and little satisfactory. I have tried the ploughing of whinny ground, intermixed with bushes of birch, with a four-horse plough, and been glad to relinquish the work, on seeing the horses stopped every few minutes with sudden jerks, while the ground was deeply turned over in many places, whilst in others it was only scratched with the points of the coulter and sock. Employed in such work, the wind of two valuable horses of my own was completely destroyed.

5952. When the ground is comparatively free of roots of all kinds, and of stones in the subsoil, it may be turned over with the plough in all places where it is practicable, and in the other parts, however isolated, the spade should be employed to trench the ground, which will therewith be turned over at a comparatively small cost.

5953. Very rough grassy ground that has been drained from a swamp, containing the roots of sub-aquatic plants, as rushes and others, should be ploughed with the four-horse plough—the only obstacle likely to occur being the choking of the beam in front of the coulter with tufts of the grass, which should either be removed with the plough-staff, fig. 5, by a person walking beside the plough; or, what is better, the grass should have been mown with the scythe before the ploughing commenced. The furrow of the four-horse plough will be both deep and broad, and will become much mellowed by exposure to the frost of the ensuing winter. It should not be turned over too early in summer or autumn, to afford time to the grass to connect the edges of furrow-slices together.

5954. Smooth grassy land that has lain comparatively in a waste state in consequence of inundations of water in winter, but is now protected by an embankment, (5744.) should be ploughed at once; and an ebb and broad furrow-slice should be well laid over to assist in rotting the grass.

5955. Deep moss that has recently been drained cannot at first be ploughed, and must therefore be dug with the spade. The surface of such ground is often very rough; and the turf, when dried, becomes very tough and difficult to reduce into mould. Deep digging is absolutely necessary where the surface turf is very rough, in order to bury it for decomposition.

5956. In trenching the site of an old plantation, the ground should be marked out in divisions of 30 feet in breadth; and 3 men working together will do more and better work than when working alone, as the one assists the others when extracting the roots of the trees. No implement is so efficient in cutting the ramified roots of a tree than the common mattock, fig. 544, which on one arm has

Fig. 544.



A MATTOCK.

a horizontal cutting face, and on the other a vertical one. It is used like a hand-pick, fig. 452; and one or both cutting faces are required alternately to cut through a strong root. An axe would soon be blunted by the earth necessarily adhering to the smaller roots, though a large thick root is easier cut through with an axe than a mattock—care being first taken to wipe off the earth from the part of the root to be operated upon by the axe. All the roots, great and small, should be laid upon the surface of the trenched ground behind the workmen, and the hollows left by them in the ground filled up, and the surface levelled.

5957. In trenching very stony ground, the foot-pick, fig. 247, is the most efficient implement for loosening them out of the subsoil, (3149.) The iron lever will be required to raise what cannot be effected by the foot-pick; and the largest boulders of all will require to be blown to pieces by gunpowder, with more shots perhaps than one. The stones should be laid upon the trenched ground. In many parts of Kincardineshire, the stones are so numerous in the subsoil as not only to afford as many as to drain the land, but, to get quit of the

overplus, "consumption dykes," as they are called, several feet in height and breadth, are erected in lieu of fences. As many as 800 tons have been trenched out of an acre in that county. In the southern parts of the county of Antrim, in Ireland, I have seen large quantities of small trap boulders trenched out of the subsoil.

5958. On improving waste land that had been the site of a plantation, or very stony ground, it should be trenched before being drained, because the cost of draining, in such cases, would be very much increased were it done before the obstructions from roots and stones were removed. Where the stones are numerous enough to drain the land, it will be cheaper to break and use them for that purpose, than to take them away and purchase tiles in their stead.

5959. The ordinary trenching of ground with the spade has been described in (3148) to (3150.) Fork-trenching, which is always accompanied with spade-trenching, has also been fully described from (3151) to (3155.)

5960. The *expense* of trenching rough ground 16 inches deep—and it should never be shallower to insure a good plough-furrow ever afterwards—is from 10d. to 1s. per pole, according to the roughness of the ground. I have had very rough ground, consisting of the large roots of a scattered wood, with brushwood of birch, alder, whin, and broom, and containing as many stones as would have half-drained the ground, trenched 16 inches deep for £6, 13s. 3d. per acre, which is practically 10d. per pole for the spade work alone—a large sum, undoubtedly, independent of draining, clearing away rubbish, and incurring other horse and manual labour. But when the ground was rendered at once from a state of wilderness to be fit for the manure being applied and covered in with an ordinary plough-furrow of mould, the expense was not inordinate. Though trenching may not be the cheapest mode, in a pecuniary point of view, of rendering land available to the plough, it is, at all events, the most pleasant and satisfactory one for every subsequent operation.

5961. Trenching may be executed at

any season; but to allow time for subsequent operations, it is best and most pleasantly done in the long dry warm days of summer, and should be finished by early autumn. The contractor should be bound to spend as much of his time amongst the workmen as possible, taking perhaps a lot to himself if he find leisure; and the farmer should have a person to superintend the work in the progress of execution, as some of the men will endeavour to make the *trenched* ground seem as high as it ought to be, although the solid ground may not have been dug to the depth it should have been. It will be the farmer's own fault in superintendence if the work be ill executed.

5962. If turf is desired for any purpose, waste land, when about to be improved, affords a favourable opportunity for supplying it. Good tough turf is not easy to be obtained, and is at all times an expensive article. A man will cast from 4 to 6 cart-loads of one ton each per day, according to the smoothness and softness of the ground. The usual thickness of turf is about 3 inches, when one square yard will weigh 54 lbs., one ton will cover $41\frac{1}{2}$ square yards, or 14 roods of 6 yards, with turfs of 12 by 18 inches. In the country the carriage is the heaviest charge against turf; and in towns it cost from 8s. to 20s. per ton, according to quality.

5963. In the improvement of waste land, it is desirable to have its surface as even as practicable, by the removal of sudden hollows and heights. No hollow should be filled up without a drain being previously made in it, to take away the water that will naturally tend towards it; and no height should be lowered without first having the upper soil removed and then replaced upon the lowered ground. Taking off and putting back the ordinary soil of a field costs 4d. per cubic yard for each operation.

5964. In levelling high gathered-up crooked ridges in clay soil, much precaution is requisite, because the soil, exposed after the lowering of the ridges, will take a considerable time to be brought into a state of fertility. A mode, however, of levelling such ridges in drained land, to avoid this inconvenience, was thus described by

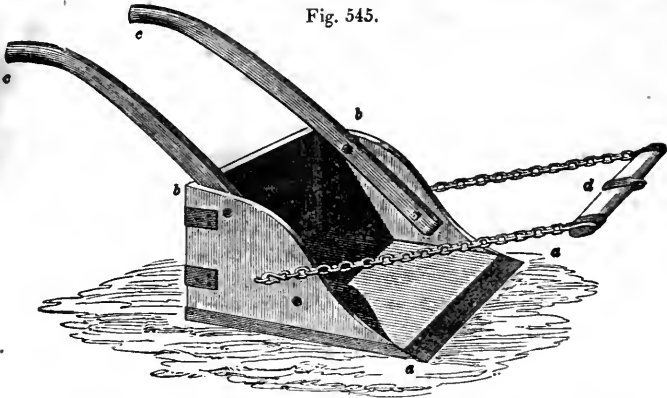
the late Mr James Carmichael, Raploch farm, near Stirling: "In winter, ploughing the land intended to be levelled and straightened in the succeeding summer, the plough was entered in the side of the ridge, exactly in the middle between the crown and the open-furrow; and thus one fourth of the ridge was *gathered up* (749,) from the open-furrow on each side of the ridge, while the open-furrow was left as open and deep as possible. The remaining half of the ridge was then *cloven down*, without gore-furrows (767,) the crown being laid completely bare, so that every ridge was divided into two. The work thus remained high and dry during the winter. In May or June following, the plough *gathered up* about two feet on each side of the crown of the ridge of the exposed subsoil, which was about 5 feet in breadth. After this it was ploughed into drills, and removed, either by shovels or with a 2-horse levelling-box, into the deep open furrows. The plough was again employed to make drills in the crown, and the subsoil removed into the open-furrows; and the same operation was repeated until the open-furrows were raised apparently above the level of the crowns. This being done, part of the formerly accumulated soil on the sides of the ridges was *cloven down* by the plough upon the recently removed subsoil in the open-furrows, on the one hand, and upon the bared crowns on the other hand. The land was then cross-harrowed, and twice cross-ploughed and harrowed alternately as deep as possible, and every inequality removed before the ridges were re-formed straight. The whole process is exceedingly simple, and its advantages are perfectly obvious; for while every particle of the original surface is thus carefully preserved, the subsoil is so sparingly and equally incorporated with it, that not a doubt can remain of the beneficial result of the operation. Where the ridges have been very broad and high, it will be found necessary to remove part of the subsoil from the sides of the ridges also after the crown has been refilled, particularly when the subsoil is tilly; but this is easily performed by 2 or 3 women or boys going after the plough, and throwing the remains of till turned up into the furrows; or, should the ridges be too broad for this, the levelling-box will effect the purpose."

5965. The labour attending this operation will depend on circumstances, such as the breadth and crookedness of the ridges, and the strength of the clay soil. In dry weather, the operation will be more expeditiously and better done than in wet, the soil being rendered light by the heat of the sun; and in changeable weather no more subsoil should be ploughed than can be removed during the course of the day.*

5966. Besides larger inequalities of

surface, minor ones require emendation, the neglect of which renders the surface of improved arable land unpleasant to the sight. The inequalities I allude to are slight hollows, low heights running across several ridges, making one side or part of a ridge higher than the other, or part of the headridge higher than the ridges, and such like blemishes. The best and most economical method of getting quit of them is by the employment of the levelling-box, fig. 545, which,

Fig. 545.



THE LEVELLING-BOX, OR SCOOP.

according to the nature of the soil to be removed, and the distance to be carried, may be worked by one or two horses. The figure represents one of the latter kind, furnished with fixed handles and draught-chains. The two sides *b a*, *b a*, having the same depth where they join the back, are curved off to nothing at the front. It is requisite for strength that it be made of hard wood; but the common willow, from its toughness and lightness, is perhaps better adapted than any other wood for this purpose. The sole of the scoop is armed with a strong shoeing of iron, terminating in a sharp cutting edge. Two skeds or bolsters, are fixed on the lower side of the sole, thinned off forward to give facility of entrance in the soil to the cutting-edge of the scoop, and upon which it runs like a sledge when filled. All the corners are strongly bound with iron plates, and the skeds upon which it runs are covered with strong sheet or hoop iron. The handles, *b c*, *b c*, are bolted to the sides, and so fitted as to bring the extremities, *c c*, to a convenient distance

for being held in the hands of the conductor. The draught-chains, with their stretcher *d*, are attached to an eye-bolt or a staple on either side of the scoop. The levelling-scoop is frequently fitted up in a manner somewhat different in the mode of attaching the handles. A strong gudgeon is fixed in each side at the place of attachment of the chains; and the terminations of the chains being an eye-bolt or link, it is passed upon the gudgeon. The handles, in place of being fixed to the sides, have an eye formed in their end and strengthened with iron, which passes also upon the gudgeon, and are held there by a washer and cotrel. A second pair of gudgeons are strongly fixed, one upon each corner of the box at the back, in a position that will pass through the handles when they are at a proper height. The handles are here also pierced and defended with iron, so as to slide freely off and on upon these second gudgeons, and their extremities brought as before to a convenient width.

5967. The method of using the level-

* *Prize Essays of the Highland and Agricultural Society*, vol. ix. p. 37-9.

ling-box or scoop is—after the plough is first made to turn over the soil lightly on the height to be removed, the levelling-box, worked by a pair of horses, then follows, and takes up, from one end of the ploughed ground, as much soil as it can contain, the conductor holding by the stilts or handles. The box is filled by the conductor allowing the handles to rise as much as that the edge *a a* of the sole shall bite the ground; and on these being drawn forward by the horses, the box is filled to any extent, when by the handles being pressed down the front edge is relieved from the ground, and the machine travels upon its skeds. On arriving at the hollow place to be filled up, the box is made by the conductor to capsize by raising up the handles, which gets quit of the load of earth; and whenever it is emptied, he levels the earth smooth by passing the box over it. Of the two sorts of levelling-boxes; the one in fig. 545 is, in my opinion, the most handy. It is easily filled by raising the handles a little, and giving the scoop a catch of the mould. It is as easily transported to its destined spot, by leaning on the handles, which causes the box to travel on its keel. It is as easily upset, when arrived at its destined place, by raising the handles a little, when the ground catches the sharp edge and overturns the box, the handles striking against and resting upon the stretcher *d*. The box is returned to its working position upon its bottom immediately, or it may move along upon its mouth, smoothing the surface till it reaches the ploughed soil, when, by a sudden pull of a rope attached to one of the handles, it regains its working position. In all these movements the horses are not stopped, but proceed from one place to another as directed, while the box is filling and emptying in constant succession. The box having the movable handles, is worked rather differently. When the handles are let free of the gudgeons by the conductor, the box easily capsizes; but unless the horses are stopped, there is difficulty in shipping the handles again quickly upon the gudgeons—which, if not quickly done, when the box regains its working position, by itself, the edge again bites the ground, and capsizes the empty box again; which will thus continue to be overturned until the handles are fastened on the gudgeons. The stopping

of the horses for this purpose necessarily loses much time. An active stout man is required to work either form of levelling-box as it ought to be done.

5968. Land so drained and trenched—and which operations may be continued during the winter and early spring—should bear, for its first crop, potatoes or turnips; and of these I would prefer the turnips, because they, being eaten off by sheep, will at once put the drained land into a state of comparative fertility. Oats are a favourite crop, for the first one, with improvers of soil, because it assists in rotting turf quicker than green crops; and where grass has been ploughed, it is the best first crop that can be taken. It is out of the question to attempt winter wheat upon newly brought in soil, in a loosened state, at so late a period of the year, even though a sufficient quantity of manure should be at hand. The soil cannot be sufficiently pulverised by spring to insure success in barley. Oats do not succeed well on trenched ground, their pabulum, the turf, being buried in the trench. Let it be decided, then, that turnips are the most advisable crop under the circumstances. Should the draining have been accomplished at a previous period, or early in winter, to preserve the *surface* of the land dry, the ground should be feered and gathered up from the flat, (749,) with a very light furrow, the hint-end furrows neatly cleared out, and gawents made in all the hollows, and across the lower head-ridge into the adjoining open ditch; in which state the land will remain safe all winter until spring arrive, when it should receive a harrowing, after which it will be ready to be formed into drills, dunged, and sown with turnip seed, as fully described for turnip husbandry, in (3204.) It has been observed that, where whins had grown, the turnips are better than after any other natural shrub.

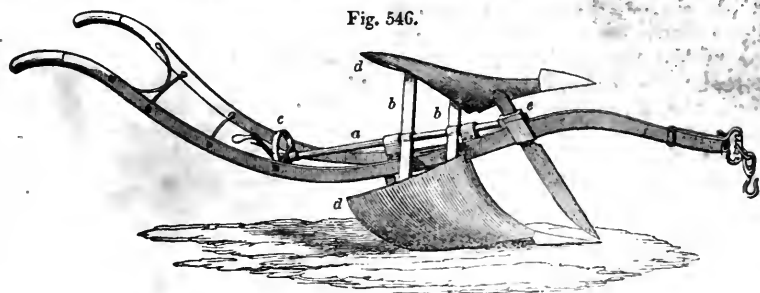
5969. It is imagined by some that, where land is thorough-drained, it is unnecessary and even injurious to put it into ridges, but rather to have it in a continuous flat without an open furrow. The object of keeping land in the flat state is to allow the rain to percolate through it alike everywhere into the drains. What particular advantage the soil can derive by the uniform percolation of the rain

through its surface I cannot well conceive, since the water must leave the soil soonest where the drains are nearest, and therefore no form of surface can possibly cause all the water to leave the soil at the same time. The division of the surface into ridges marks it usefully for the distribution of seed and labour; and when labour of whatever kind is bestowed on ridges, appropriated to different labourers, each responsible for the work he does, the work of each is distinguishable from the rest; whereas, were the ground not laid out into ridges, the ploughs must either follow one another round the circumference, or one plough be left to do all the work of each field. Where ploughs follow one another, the work is invariably ill done, one furrow being broader or deeper than another—it being well known that no two ploughmen turn over the ground exactly in the same manner. It is because each man executes

the piece of work appropriated to him over two or four ridges that the work appears distinctive, and each man's distinctive style of work is not obliterated by any one following him. But the common plough cannot plough the surface without leaving open furrows, and were the attempt made, one open furrow at least must be left either on each side or in the centre of the field; and in either case, the ploughs must have lost much time in going idly from one side of the field to the other. But although the common plough could lay the land flat without an open furrow, strong land should never be laid flat on any account.

5970. The only implement which can turn over the furrows in one direction is the turn-wrist plough: the one invented by the late Mr Wilkie, Uddingston, is represented in perspective in fig. 546. It has two mould-boards *dd*, whose inside faces are attached

Fig. 546.



WILKIE'S TURN-WRIST PLOUGH.

together by means of two iron bars *bb*, so as when one mould-board is in operation the other is elevated in the air. These bars are attached at right angles to an iron spindle *a*, which at one end *c* is seated in a plummer block, and furnished with a crank-handle, and at the other terminates in the coulter-box *e*. To the crank-handle *c* is attached a spring which falls into a notch on each side of a semi-circle, as the spindle *a* is turned round to place either mould-board in its position for ploughing; and while doing this it also acts upon the head of the coulter so as to cause its point to stand over the point of the sock which in this implement is attached to the mould-board instead of the head. This plough acts in the same manner as the common plough, when the mould-board is set as seen in the figure, the furrow-slice being turned

over to the right hand; and on coming to the land's end, the other mould-board is brought down on the left hand side of the plough, and by it the furrow-slice is turned over to the left hand—which is still placed in the same direction as when the ploughing was turning over the furrow-slice to the right hand, in moving in the opposite direction. The ploughman requires some practice to become acquainted with the working of this plough, as he does not at first feel at home when the furrow-slice is turning over to the left hand.

5971. It is known that, in ploughing steep land with the common plough, the soil has always a tendency to come down the incline. The turn-wrist plough, laying all the furrows in the same direction, might be usefully employed in turning the

furrow-slice up the inclination, which, on repetition, would have the effect of retaining the soil upon it.

5972. Peaty soil on the sea-shore has been recommended to be planted with the tussac grass, *Dactylis cæspitosa*. "This remarkable grass is perennial, and forms, with its densely-matted roots, crowded but isolated hillocks, or tumuli, 3 to 6 feet in height, and 3 or 4 feet in diameter, from which the leaves and stems spring. Roots fibrous, the fibres very tortuous; stems or culms numerous, rising from the hillocks erect, branched, 3 or 4 feet long, smooth, compressed, leafy, and pale yellow, abounding in saccharine matter, and, when young, esculent even for men." It was observed in 1842 by Dr J. D. Hooker growing luxuriantly on peaty seaward exposures, and to whom the merit is due of its introduction into Europe. It abounds on the shores of the Falkland Islands, and is much relished by cattle and horses.*

5973. Its cultivation has been attempted in the Island of Lewis by Mr Matheson, and by Mr Traill at Woodwick, Island of Ronsay, Orkney. At Lewis it succeeded only at Holm, in 1844, in deep brown moss of medium dryness, close to the sea, and on being delved over was cut in small pieces with the spade, and the seeds of the tussac grass were then sprinkled in and roughly covered with a rake, and trampled in with the foot. Its stools in the second year were almost as strong as those in its third, and it shed its seed in both years. In the spring of 1847, three acres of the same moss, which had been drained with three feet deep drains at twenty feet apart, with shoulder and wedge drains, were dug 12 inches deep; and after it was broken with a hoe, and a sprinkling of gnano applied, single plants of the tussac grass were dibbled in at 3 feet 4 inches apart. The plant was succulent, with broad green leaves, and three feet long, the second as well as the third year, and many of the stools when planted out were found to have 500 plants. The moss should be dug in January, and the plants set in February, March, and April, with a slight spreading of moss thrown over them to prevent the sun drying the moss too much, and May and June are too late for their transplantation. Sea-ware spread on the surface keeps the leaf greener, and the peat safer; and the plants must not be more than a quarter of a mile from the sea, to receive its spray.

5974. The nutritive matter contained in tussac grass is as follows:—

100 parts of the grass.	Analysed by Dr Fromberg,	Analysed by Dr Voelcker, Sept. 1847.		Whole plant.
	Sept. 1846.	Lower part.	Upper part.	
Water,	45.50	86.09	75.27	80.68
Watery extract,	9.40	4.34	3.64	3.99
100 parts dried at 212°.				
Watery extract,	17.24	31.17	14.72	22.94

5975. The composition of the tussac grass is as follows:—

	RECENT STATE.		DRIED AT 230°.	
	Lower part.	Upper part.	Lower part.	Upper part.
Protein compounds,	2.47	4.79	17.81	19.38
Sugar, gum, and extracting matter, extracted by water,	3.32	3.64	23.88	8.93
Other nutritious substances insoluble in water, but extracted by potash,	1.30	3.07	9.20	18.63
Woody fibre, (cellulose with a little albumen,	5.68	11.86	40.88	47.94
Saline matter, (ash,)	1.14	1.37	8.23	5.12
Water,	86.09	75.27	..	..
	100.00	100.00	100.00	100.00

5976. Its ash affords these proportions of ingredients:—

	From Lewis.	From Mr Lawson's Nursery.
Chloride of sodium,	12.21	2.62
Chloride of potassium,	36.01	17.29
Sulphate of potash,	14.34	12.69
Carbonate of potash,	14.16	17.98
Carbonate of lime,	4.42	14.37
Carbonate of magnesia,	0.41	5.84
Phosphate of magnesia, and a little phosphate of lime,	14.74	12.96
Phosphate of iron,	1.64	4.15
Silica,	3.09	11.84
	101.02	99.74
Percentage of ash,	6.29	7.79

The proportions of alkaline salts in both is very large; in this they agree with the turnip. The proportion of phosphates is small compared with grass; in this they resemble turnips and fruits. The quantity of silica is small for a grass. The differences of the two specimens are considerable; the Lewis gives more alkalis and chlorides, and less lime and silica, than Mr Lawson's, which might have been expected from the difference of locality.†

ON TRENCH AND SUBSOIL PLOUGHING.

5977. Since the general draining of the soil received the assent of the agricultural community, deep ploughing has presented itself to the attention of the farmer in a favourable light. It was at once imagined, that, if the soil were stirred to a greater depth than the common plough reached, the drains would operate to dry the land sooner and more effectually. In this opinion, I conceive, is involved an erroneous view of the effects of deep ploughing. Stirring the ground to a greater depth would make the rain that fell on its surface to descend more quickly to that depth; but the accumulation of

* Lawson On the Cultivated Grasses, p. 18.

† Transactions of the Highland and Agricultural Society, March 1848, p. 247-50.

water there would not cause the drains to dry the land the sooner, unless the ploughing had been as deep as the depth of the drains, which is impracticable: they would therefore only carry off the water that came to them, and no more would reach them in the course of the year than the ordinary proportion of the rain that annually falls, which is just the same after the land had been deep-ploughed as it was before. Deep-ploughing, therefore, has another and higher object than to convey water more quickly to drains.

5978. The great object of deep-ploughing ought to be to increase the depth and pulverise the soil to a finer state, in order to give the plants cultivated a larger range for their roots to search for natural, in addition to the artificial food supplied them; and, in my opinion, the pulverisation will be better and easier effected by the deep-ploughing, after the drains have rendered the land as dry as they can, than before that event has taken place. So far, therefore, ought deep-ploughing to be made an auxiliary to drains. As a duct for the conveyance of water, it ought to be deferred until the drains have performed their legitimate office of drying the land, when deep-ploughing will come in with powerful effect to deepen and pulverise it into a state in which it will continue for a considerable time thereafter. To attempt to pulverise soil, before it has been thoroughly dried by draining, is to begin at the wrong end of the process.

5979. Various forms of implements have been devised to descend as far into the soil as to stir the subsoil effectually, and they have obtained the name of *subsoil* and *trench* ploughs, according as they affect the subsoil. The subsoil-ploughs stir the subsoil lying under the active soil, without affecting their relative positions, whereas the trench-ploughs commingle

more or less of the subsoil with the active soil of the surface.

5980. The subsoil-plough, which was first tried as a modern invention, was the one produced by the late Mr Smith of Deanston in 1829. It was an implement of the great weight of 5 cwt. Recent improvements upon it, and particularly those effected by Mr Slight of Edinburgh, reduced its weight to from 2 to 3 cwt. As other subsoil-ploughs of recent introduction have superseded it, it is unnecessary to do more than give its form in fig. 547, drawn by four horses.

5981. The effect of subsoil-ploughing with Smith's plough, being merely to stir the subsoil without affecting its relative position with the upper soil, the best way of performing the operation is, as I conceive, in the following manner; and it may be executed either in winter or in summer, according as it is made to form a part of the spring or summer's operations. It is best executed *across the ridges*: let, therefore, a feering of 30 yards in width be opened across them with the common plough along the upper fence of the field—and parallel and close to it, if it be straight—and another at 30 paces distant, the subsoil-plough following in both the open feerings, with 4 horses—one man holding it while the horses are driven by another. The common plough then closes the feerings, and ploughs from one feering to another until the open furrow is formed in the middle of the feering, followed implicitly all the time by the subsoil-plough. Feering after feering is thus made and ploughed with the common plough, followed by the subsoil, until the whole field is gone over, with the exception of rather more than the breadth of a ridge at each side of the field, upon which the horses had turned. Fig. 547 gives a representation of this mode of

Fig. 547.



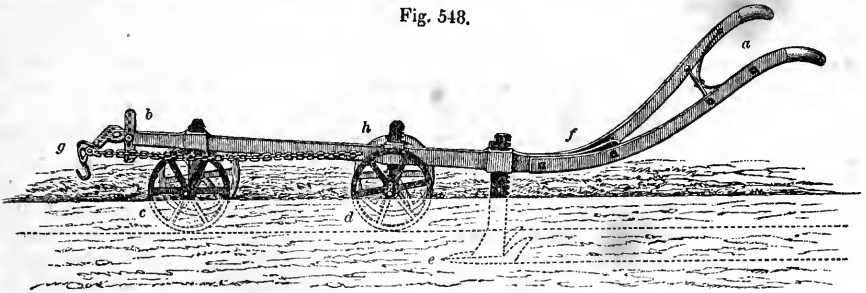
THE MODE OF ORDINARY SUBSOIL-PLOUGHING.

subsoil-ploughing, where the ploughs and horses appear in black, and where the common plough with 2 horses precedes the subsoil one with 4. The depth taken by the common plough is the usual one of 8 inches in stubble, which is seen as the upper furrow, succeeded by the subsoil-plough, which takes usually 8 inches more, and whose furrow is seen in section below that of the other plough, making both furrows 16 inches deep. Care should be taken not to bring the subsoil-plough within 3 inches of the covering of any drain, otherwise the materials of the drain will be injured. The drains in the figure are supposed to be 36 inches deep, filled 12 inches with duct and small stones, and placed in every open furrow at 15 feet—the breadth of the ridges. This figure is not meant to give the exactly relative proportions of the different objects composing it.

5982. The unsteady action of the Deanton subsoil-plough rendering it difficult to hold, and the same cause rendering its

action in the subsoil uncertain, it is more than probable that the surface which it leaves upon the plane on which its sole moves is uneven, both in the direction of the length of the furrow, and in the relation which the sole of one furrow bears to that of another. It is evident that, if its furrow-sole in its length is undulating, and that one furrow-sole, in its breadth, is higher and lower than the contiguous ones, the plane of the furrow-sole across the ridges will be so irregular that the water, descending the inclination of the ground, will be interrupted in its progress to the drains. To give the plane of the sole a uniform depth, it is only necessary to introduce wheels upon the beam, which will cause the sole-furrow to preserve a parallelism with the furrow-sole left by the preceding common plough. This obvious means of steadying the action of the subsoil-plough was introduced into a subsoil-plough invented by Mr Read, which is represented in fig. 548 as improved by Mr Slight, and where the alteration will be

Fig. 548.



READ'S SUBSOIL-PLOUGH.

observed to have converted the plough into the form of a grubber. The implement consists of a malleable iron beam, *b, f*, to which, at one end, *f*, are attached two handles, *a*, in the same manner as those of the Deanton subsoil-plough, in fig. 547. To the other end is welded an iron slot, *b*, placed perpendicularly, and punched with holes, into any one of which the bridle *g* may be fastened by means of a bolt and cotrel. The bridle *g* is winged to the land-side, in order that the two or four horses which are employed to draw the plough may walk upon the hard ground; and to sustain their lateral draught, one end of a chain is affixed to the extremity of the wing of the bridle carrying the draught-hook, and the other is attached to the beam at *h*. The wheels *d* and *c*, coupled

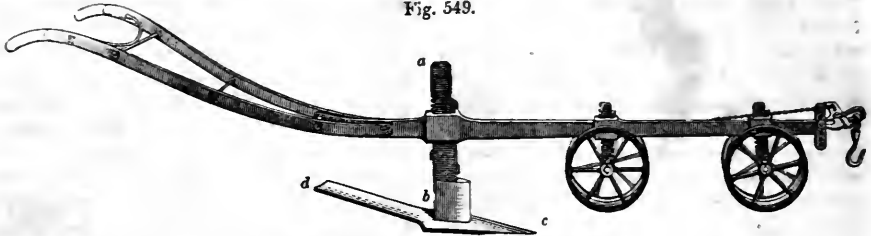
in pairs on axles, are attached to shanks which pass through boxes in the beam, the same as the coulter-head in the common plough. The shank of the double-feathered share *e* is affixed in the same manner as the wheels to the beam. The dotted line below *c, d* shows the line of the furrow-sole made by the plough which preceded this implement in the work of subsoiling; and it should never be less than 8 or 9 inches below the surface of the ground. The dotted line behind the share *e* shows its line of motion, and the distance between these lines is regulated by the depth given to the axles of the wheels *c* and *d* below the beam *b, f*, which may vary from 6 to 9 inches. The beam resting on the two pairs of wheels *c* and *d*, and the ploughman in the bottom

of the furrow made by the preceding plough, with a hold of the handles *a*, afford so steady a motion to the share *e* that it may be regarded as uniform, and its work will be much better performed than that by the Deanston subsoil-plough.

5983. In 1849, the Marquis of Tweeddale effected an important improvement on

Read's subsoil-plough, that, while its useful form was retained, its action was altered from a simple subsoiler, which merely stirs the subsoil, and leaves it where it found it, to a trenching-subsoiler, which effects a mixture of the subsoil with the surface soil. The implement is represented by fig. 549, by which it will be seen that the frame of the implement is

Fig. 549.



THE TWEEDDALE SUBSOIL TRENCH-PLOUGH.

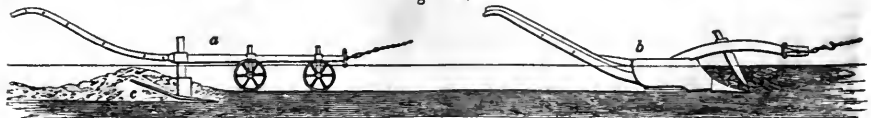
preserved exactly to Read's form, as improved by Mr Slight, and the important alteration is exhibited in the share and its appendages. These consist of the share *b c* attached to a shank *a b*, and produced hindwards into the tail-board or elevator *d*. The shank is a bar of the best scrap-iron, and at bottom is forged with a club-end, fitted to receive the attachment of the body of the share by welding or by rivetting; and to the hind part of the latter the tail-board is strongly fixed by bolts.

5984. The Tweeddale subsoil trench-plough having a share 14 inches in width, a common plough is inadequate to go before it, to open a sufficient furrow for its passage. Lord Tweeddale supplied the want by the true philosophical mode of induction, with numerous and untiring experiments on a large scale. By these he constructed a plough having its mould-board formed upon a new system of lines and

of dimensions, that render the plough capable of taking a furrow-slice 12 inches wide and 13 inches deep in the most effective manner. This plough, named the Tweeddale Plough, leaves a clean and flat-soled furrow; but the furrow-slice taken by it, in place of being turned over in an entire form, in the manner effected by our *fine-working* ploughs, is only so far turned, and at the same time broken up, as serves to present the soil in the best possible state to the ameliorating effects of atmospheric influences. In this respect the plough seems to stand unrivalled; and since the extinction of the old Scottish wooden plough, no implement has approached the point to which this has attained, for enlarging the extent of surface exposed to the atmosphere.

5985. A sectional elevation of both ploughs, as they appear in actual operation, is represented in fig. 550, where the Tweeddale plough *b* is taking its furrow

Fig. 550.



THE TWEEDDALE SUBSOIL TRENCH-PLOUGH AND THE TWEEDDALE PLOUGH IN OPERATION.

of 13 inches in depth, followed by the trenching subsoil-plough *a* going 6 inches deeper, making the trench-subsoiling 19 inches deep. The wheels of the trenching-plough are seen resting upon the sole of the furrow just taken out by the Tweeddale

plough, while the tail-board appears doing its office of elevating the slice of subsoil, forming a continuous succession of the void space *c* under its extremity. This void is with equal continuity filled in, partly with portions of the upper soil,

which fall down between the edges of the tail-board and the sides of the open furrow, the remainder being filled up by the return of part of the elevated subsoil, broken and pulverised by falling over the end of the tail-board, as the implement passes from under the subsoil, while other portions of the elevated matter remain intermixed with the upper soil. The trenching and subsoiling effected by these two ploughs is much more complete than that done by the spade, and also by the fork, since the usual trenching effected by these leaves the relative positions of the soil and subsoil the same as they found them, though each may be respectively broken and pulverised. In this double process with the ploughs, the subsoil is not elevated entirely to the surface, but to within 4 or 5 inches of it, and, in its elevation by the trenching-plough, becomes very intimately mixed with a portion of the surface-soil turned over by the preceding Tweeddale plough; and so intimate is the commingling of the soil and subsoil, that, in digging to the bottom of the ploughed ground with a spade, they can scarcely be distinguished. The distinction, in fact, can only be observed when the subsoil happens to be of an uncommonly dark red or bright yellow colour; and when of blue, green, black, or grey, the mixture is not discernible.

5986. One point of excellence attending this operation is the leaving the furrow-sole quite flat and even, as has been demonstrated by the removal of the loose soil to the bottom of the furrow, whereas ordinary subsoil-ploughs leave it ribbed.

5987. The breadth of the share of the subsoil-trencher being 14 inches in width, and that of the Tweeddale plough only 12 inches, it follows that an inch of each side of the furrow-sole is twice ploughed, and consequently that no ribs are left in the subsoil on either side of the furrow-sole, which will thus be made quite smooth and flat—an immense advantage over every other form of subsoil-ploughing.

5988. Ordinary subsoiling is recommended because the air is admitted to the subsoil which is kept below and only brought up, if ever, after it is supposed to have become ameliorated; whereas, in

trench-subsoiling, it is at once mixed with the upper soil, and operates with it as so much fresh soil. The terror expressed by many farmers of bringing up the subsoil near the surface I deem wholly chimerical, for although injury may have been sustained, in some instances, by bringing up the subsoil at an improper period of the rotation—when a white crop, for instance, was to be taken, or before the land had been thorough-drained—no instance, that I am aware of, can be adduced of injury having been sustained after thorough-drainage, by any green crop, which ought always to be taken after trenching and subsoiling.

5989. One great advantage attending this mode of trenching and subsoiling is, that in treating the soil so in autumn, the soil requires very little working in spring to prepare it for a green crop; and should circumstances prevent the working of the land for turnips, such a trenching may be given within three weeks of the time for sowing turnips, with marked success. When a facility such as this is put into the power of the farmer, to work his land in a short time, and in the most efficient manner, two good results must ensue—the whole of the fallow-break may be devoted to a green crop, and a smaller strength of horses will do all the work that is at present done.

5990. I have had repeated opportunities of observing the progress of improvements effected by these valuable implements on the farms in the Marquis of Tweeddale's own hands, of Yester Mains and Broadwoodside. The latter farm has been managed for the last six years under the system of *deep* ploughing; and it is consistent with my own knowledge that, at the commencement of a six years' course of improvement, the land on that farm was not worth more than 7s. or 8s. per acre. The present value may safely be taken at £2 per acre. The rationale of this enhancement of value is to be found in a perfect system of drainage, followed *some years afterwards* by the deep ploughing. The manuring application has not been more expensive than is commonly followed by every judicious farmer. The general results may challenge comparison with those of the best land in the country.

In 1849 the turnips were superior to the general crop, and in 1850 they are superb, while the wheat crop was both bulky and abundant.*

5991. Upon every farm commanding the services of 4 pairs of horses, this process might be conducted on the same scale of depth as the Marquis of Tweeddale pursues; but where there are only 3 pairs, the Tweeddale plough that precedes the subsoil-trenching one being drawn by one pair, the trenching would be executed to the depth of 15 inches. The subsoil-plough should always be drawn by two pairs of horses, to do justice to its searching and effective powers. The two ploughs easily turn over an acre a-day, either in autumn or spring, the horses are not oppressed, and the men are quite able for the work.

5992. A great element of fertility has lately been put into the Marquis of Tweeddale's possession, in the vegetable matter obtained by draining the loch at Danskin. It can be put into carts out of the basin of the loch by steam power for 2d. per $1\frac{1}{2}$ cubic yard, and it is applied to the land at not less than 100 cart-loads to the acre. When spread, it is reduced small by the action of the Norwegian harrow, fig 246, and then ploughed in with a deep furrow by three horses abreast. Hitherto the effects of that quantity, in both the field and the garden, have been equal to the ordinary quantity of farmyard dung.

5993. So very diversified is the opinion of farmers on the effects of ordinary subsoil-ploughing, that I suspect some error is committed by one or other party in conducting the process. One likely error in the performance of the process is in being too soon after the draining. The late Mr Smith recommended one year to elapse between the draining and the subsoiling. I should say one rotation ought to intervene. Be that as it may, the diversity of effects experienced by it warns me not to adduce any instance of failure or success, in case they might mislead parties into error.

5994. Trenching with the fork is more efficient than ordinary subsoil-ploughing as regards the stirring of the soil and subsoil; and it is a more perfect operation, inasmuch as it exposes the subsoil to view, breaks every portion of it to a greater depth, and frees it of every stone that, from its size, would injure the implements in any future operation of culture.

5995. It was stated on the occasion of the show of the Highland and Agricultural Society at Glasgow in 1844, when fork-trenching was exhibited under the direction of Mr Houston, of Johnstone Castle, Renfrewshire, that men undertook to trench the ground with the fork for £2, 8s. per acre—which would be very cheap for that efficient mode of bringing in rough ground. But in one instance tried in 1847, by Mr Milne of Milne-Graden, Berwickshire, the cost of fork-trenching 20 inches in depth was £6, 14s. 5d. per acre—which is a nearer approximation to the truth, I suspect, than the other sum.

5996. It would appear, from the large results obtained at Yester, after the application of the ordinary quantity of manure, that it is to the deepening and pulverisation, and perhaps also in part to the freshening of the soil, by the mixture of subsoil and surface-soil, that the increased return is to be ascribed; and if so, (and no other reason seems at hand to account for the enlarged increase,) it should be the farmer's endeavour to keep the soil in a constant state of pulverisation and deepness, by a repetition of the same process that attained those ends at first. It may be questioned that the process will continue to produce as good results for an indefinite length of time. Jethro Tull, we know, believed that pulverisation and exposure to the air was all that soil required to produce crops as long as he pleased; but his opinion did not outlive his own experience: and had it been otherwise, we cannot doubt but that it would have been adopted by some practical man, and put to the test of experience, long ere this period. Even if experience went a long way to establish the efficacy of pulverisation of the soil, it would be unwise to neglect the assistance of good manure; and the very utmost we can endeavour, to become independent of manure, is to prove that the farm can every year produce a sufficiency to maintain its own fertility for an indefinite period. If the air, as an element, supplies every year as much of the produce as to compensate for what is disposed off the farm, the support of the farm is as much as we can expect from the soil by any method of culture. At Yester, the source of perpetual fertility to the soil is available at a cheap rate, in the possession of the vegetable mould at Danskin and elsewhere; and the best way of using it seems to me to put a large doze of it in the subsoil by the subsoiling process, while the surface-soil is sustained by the ordinary manure.

5997. I have heard it alleged that there is something particularly good in the subsoil at Yester, which causes it to produce the effects it does. My opinion of that subsoil is, that it is about the worst I ever saw. It consists of clay, and sand, and stones; the earthy matter being of different colours, the blue and the red perhaps prevailing; while patches of yellow, black, and grey are occasionally turned up. Why such a subsoil should be particularly good, it is difficult to believe. Had subsoils and surface-soils always

* *Journal of Agriculture*, January 1850, p. 265.

been commixed, as is done by the Yester process, the apprehension about the bringing up of the subsoil would have subsided. I express myself thus, because, having used the trench-plough drawn by four horses very much in the ploughing of my own land, and having brought up in that process much of very ill-looking subsoil, and experiencing no harm, but a great deal of good, from it, I feel no apprehension in the result from any subsoil. The only precaution I ever saw necessary was to mix the soils only when a green crop was about to be taken, and never when a white one.

5998. The subsoil of three of the fields at Broadwoodside was analysed by Dr Anderson, at the Highland and Agricultural Society's laboratory in Edinburgh. The specimen No. I. was taken from land not good, especially for wheat; No. II. from poor soil and stiff to work; and No. III. from land best adapted for wheat, the stiffest of the three, and consequently not adapted for turnips. The last specimen had a light colour, while the other two were red.

	No. I.	No. II.	No. III.
Water,	1.52	1.82	1.04
Peroxide of iron,	5.49 } 8.36	6.36 } 8.59	1.25 } 3.36
Alumina,	2.87 } 8.63	2.23 } 8.59	2.11 } 3.36
Insoluble matter,	86.39	80.66	91.94
	96.27	91.07	96.34

The remaining constituents, organic matter, lime, magnesia, alkali and iron, were not determined—the object being to ascertain the nature of the clay. No. III. contains a much larger amount of sandy matter, and smaller quantity of clay, than the other two. The sum of the peroxide of iron and alumina, which are specified above, may be taken as the measure of the clay, which amounts to above 8 per cent in No. I. and II., and only a little, above 3 per cent in No. III., which lies under the heaviest soil. The advantage of mixing the subsoil and surface soil is here obvious. All the soils are poor, and on Nos. I. and II. turnips might be grown, but not wheat; and wheat but not turnips in No. III., which was too stiff. Now that the commixture of subsoil and soil has taken place, all the three fields are rendered capable of growing both wheat and turnips. Such an investigation of the subsoil of other localities might produce equally good results.

5999. The vegetable mould from the bottom of the drained loch at Danskin, has also been analysed by Dr Anderson, with the view of ascertaining the quantity of nitrogen and humine contained in it. No. I. was taken from the surface, and No. II. from the bottom of the deposit, which is there about 8 feet in thickness. It is necessarily wet when first spaded; but that subjected to analysis was rendered, what in common language may be termed dry, but nevertheless it contained a large proportion of water, thus:—

	No. I.	No. II.
Water,	31.78	49.49
Nitrogen,	0.89	0.85
Humine,	6.00	16.82

The nitrogen present is to be considered as decidedly large, amounting to 1.5 per cent as the

substance was examined; but when the matter is applied as taken from its site the proportion must be so much the less. Little doubt, however, can exist of the importance of the matter when added to a poor soil, supplying as it does by no means an inconsiderable amount of nitrogen. This vegetable matter, when fresh cut by the spade, is of a brown colour, but changes to an intense black on exposure to the air.

6000. Lord James Hay of Seaton, Aberdeenshire, has lately invented a subsoil-plough, the working part of which consists only of a coulter or shank brought forward to a point, and furnished with a slightly raised feather on each side. It is fastened into a box in the beam, like the coulter of the common plough. The beam consists of a bar of malleable iron, resting on the fore part upon an axle, connecting two somewhat high wheels, and furnished at the end with a slot, to which the bridle is attached by a bolt. A pair of handles run up from the hinder part of the beam. To allow of the coulter being sent deeper into the soil, the beam can be attached to the under side of the axle. The action of this implement must be confined to the making of a single rut in the subsoil when following a common plough in the bottom of its furrow, and one such rut in the bottom of any furrow must, I conceive, leave a series of ridglets in the bottom of the subsoiled furrow—a state exactly the opposite left by the subsoil-trencher of the Marquis of Tweeddale, which we have been considering.

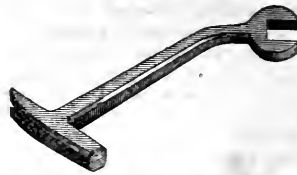
6001. Trenching is practised in Flanders, as we do subsoiling, in the ordinary course of cropping. "This remarkable practice," says Dr Radcliff, "is confined to the lighter soils, and is unused where the strong clay prevails. In the districts in which it is adopted, the depth of the operation varies with that of the soil; but till this shall have arrived at nearly 2 feet of mellow surface, a little is added to it each trenching, by bringing to the top a certain proportion of the under stratum, which, being exposed to the action of the atmosphere, and minutely mixed with a soil already fertilised, gradually augments the staple till the sought-for depth be acquired. In the Pays de Waes there seems to be little necessity for any further deepening; but the repetition of the practice itself is as periodical as the recommencement of the rotation. It is performed with a spade, the iron of which is 15 inches, and the handle 2 feet in length. The labourer standing on the last formed trench, with his left hand at the bottom of the handle, and his right near the top, by the weight of his body, and without the assistance of his foot, sinks the spade about 18 inches, and, standing sideways, throws off the soil with a peculiar sleight and turn of the wrist, so as to lodge it in an oblique position in the trench, and against the preceding line of work, retiring as he casts it from the spade, and thereby effecting some little mixture of the two strata, though the upper surface is, at the same time, placed below the other. The object of this practice is not only to let a surface rest that has

been 7 or 8 years employed in the production of various crops, but to bring another into action, which has not merely had the advantage of repose, but the enrichment of a considerable portion of manure, which, in a porous soil, cannot have failed to find its way to the lower stratum. To the universality of the habit for ages back, much of the fertility of the Pays de Waes is to be attributed. It is particularly observable, that in any district where trenching takes place, the quantum of manure is diminished, and the number of ploughings are less, so that, eventually, it is not so expensive a process as at first view it may appear: nevertheless, a fair proportion of manure is considered essential in the first season; for though the under stratum has not only had a long exemption from duty, as well as the annual acquisition of such parts of the manure as may have been drained through the upper soil, yet it possesses a coldness which requires a stimulant to bring it into action. The soil which has undergone this operation is easily worked, and the trenching seems to go forward expeditiously; indeed, in any of the light and deep soils, the labour is not severe. In the Pays de Waes it is performed by the piece, to the depth of 16 inches, for about L.1, 12s. the English acre. The cheapness of the execution is a great encouragement to the practice; but this turns upon the price of labour, which, in this district, is 15d. a-day, and chiefly upon the facility of a loose and pulverised soil. Some have sought to economise, by the use of two ploughs, the second working to a considerable depth; but the objection made to this by skilful farmers in the vicinity of St Nicolas was, that sufficient depth was not thereby attained, nor were the two strata by this operation sufficiently blended; for though, by the spade, they are made to change places, yet by the oblique manner in which the mould is placed in the trench, a certain degree of mixture of the upper and under soil is effected, which is considered of importance.*

6002. Digging soil with the spade will cost from 1½d. to 2d. per perch, or from 20s. to 26s. 8d. per acre; digging lea at 2½d. per perch, or 33s. 4d. per acre; and trenching lea, 12 inches deep, 5d. per perch, or 66s. 8d. per acre; at all which rates the men will earn each from 1s. 6d. to 2s. a-day. In digging light soil, or any soil in a friable state, the spade should be driven to the head into the ground by one pressure of the foot, and thus 20 cuts may be made in one minute. In Ireland a perch of soil is dug nine inches deep, at the same cost that half a perch of drain, 2½ feet deep, is cast out; but more wages should be obtained for casting drains than digging soil, to provide against the extra wear and tear of shoes and clothes, and the risk of injuring health by cold and wet. The most economical way of digging a large piece of land is to set from 20 to 30 diggers at work together, at so much per acre, and place a confidential man over them to see that every spadeful is properly formed and turned over.†

6003. Subsoil-ploughs, and indeed all ploughs, should always be provided with a useful appendage, an iron hammer, fig. 551. The head and

Fig 551.



THE IRON HAMMER NUT-KEY.

handle are forged in one piece of malleable iron, the latter part being formed into a nut-key. With this simple but useful tool the ploughman has always at hand the means by which he can, without loss of time, alter and adjust the position of his plough-irons,—the coulter and share,—and perform other little operations, which circumstances or accident may require,—for the performance of which most ploughmen are under the necessity of taking advantage of the first stone they can find, merely from the want of this simple instrument. The hammer is slung in a staple fixed in the side of the beam in any convenient position. This little appendage is confidently recommended to all ploughmen, as an essential part of the furniture of the plough.

6004. In removing ploughs from one field to another, or along a hard road to a field, instead of sliding them upon their sole-shoe, which is difficult to do when they have no hold of the ground, or upon the edge of the feather of the sock and the side of the mould-board—which is a more easy mode for the ploughman than the former, and is consequently more commonly taken—every ploughman should be provided with a plough-slide, a simple and not costly implement, as represented in fig. 552. It consists of a piece

Fig. 552.



THE PLOUGH-SLIDE.

of hard wood 3 feet 4 inches long, 8 inches broad, and 2 inches thick, in which a long staple, *a*, is driven to take in the point of the sock; and at *b* are fastened two small bars of wood, longways, and at such distance from one another as to take between them the heel of the sole-shoe of the plough. On the under side of the board is nailed two pieces of flat bar iron, to act as skeds to the slide. Upon this implement the plough may be conveyed with comparative ease along any road or headridge.

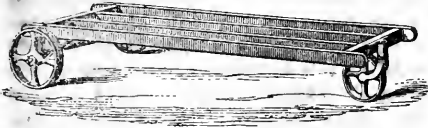
6005. In like manner, a slide or carriage should also be provided for removing harrows from one field to another. The usual practice is to put them as they are coupled together upon a cart one above another, and the probability will be that one or more of the ties are lost in the conveyance. A much safer and more convenient mode of carrying them is on

* Radcliff's *Agriculture of Flanders*, p. 166-9.

† Yule *On Spade Husbandry*, p. 86, 2d edition.

a carriage such as is represented in fig. 553, which consists of a frame of wood sparred, in length to take on a pair of harrows coupled with

Fig. 553.



THE CARRIAGE FOR CONVEYING HARROWS, &c.

their master swing-tree, and in breadth perhaps $3\frac{1}{2}$ feet. The hind part of the frame rests on crutches supported upon the axle of two wheels, the upper part of the rim of which is below the level of the top part of the frame; and the fore part rests upon a castor which allows the carriage to be turned when desired. A horse is yoked to two eyes in the fore-bar of the frame by the hooks of the plough-chains, to draw the carriage by. The harrows are piled one above the other upon the framing. Such a carriage may convey other articles to and from the fields.

6006. The Tweeddale subsoil-trench-plough is well adapted for the breaking up of *moorband pan* in the subsoil. I have not had much experience of the obduracy of this substance, as in any case within my experience it did not exceed 2 or 3 inches in thickness, which were easily ripped up with the 4-horse plough, and as easily mouldered down to dust on exposure to the winter's frost; yet there are places in Aberdeenshire and Morayshire where it is so thick and hard that extraordinary means are required to break it up. A remarkable and extensive band of this substance was encountered by Mr Roderick Gray, Peterhead, when improving part of the waste land of the property of the Governors of the Merchant Maidens' Hospital of Edinburgh in that neighbourhood. The moory surface was ploughed with 4 horses. "At first the plough ran upon the pan, which it seemed impossible to penetrate; various trials were made, and the plan which ultimately succeeded was to have 4 men employed at the plough, and these were engaged as follows:—One with a pick and spade made a hole where necessary, until it reached below the pan, and entered the plough at this hole; another held the plough; the third held down the beam, and kept the plough below the pan; and the fourth took care of the horses. In this way the upper stratum and pan were broken, and afterwards they were brought into a sort of mould by the grubber and harrows."* However obdurate this substance may be to break up, it will yield to the air, and moulder down into an innocuous powder of sand and gravel.

6007. Professor Johnston thus explains the formation of moorband pan. "It is to the lingering of unwholesome waters beneath, that the origin of many of our moorlands, especially on higher grounds, is in a great measure to be attributed. A calcareous or a ferruginous

spring sends up its water into the subsoil. The slow access of air from above, or it may be the escape of air from the water itself, causes a more or less ochrey deposit, which adheres to and gradually cements the stones or earthy particles among which the water is lodged. If the water contains *sulphate* of iron, the air from above will impart to its iron an additional quantity of oxygen, and cause a portion of it to fall in a state of *peroxide*. If the iron and lime be present in a state of *bi-carbonate*, the escape of carbonic acid from the water will cause a deposit of *carbonate* of iron or of lime. Any of these deposits will cement the earthy or clay particles together. Iron, however, is often held in solution by an organic acid (the *crenic acid*) which becomes insoluble, and falls along with the iron when the latter has absorbed more oxygen from the atmosphere. Hence the large quantity of organic matter which bog iron ores, moorband pans, and deposits from springs and drains, so often contain. Thus a layer of solid stone is gradually formed—the moorband pan of many districts—which will allow neither the roots of plants to descend, nor the surface water to escape. Hopeless barrenness, therefore, slowly ensues. Coarse grasses, mosses, and heath grow and accumulate upon soils not *originally* inclined to nourish them, and by which a better herbage had previously been long sustained."†

ON THE LIMING OF LAND.

6008. Lime has been directly applied to the land in the agriculture of this country for a very long period of years. The object of applying it has always been the same—to increase the crops by stimulating the action of the soil. It was supposed to act in two ways—directly upon the vegetable matter in the soil, and directly upon the soil itself, by altering its texture. When wanted to act upon vegetable matter, it was applied to boggy soil after it had been drained, or to deaf soil that had long been under an exhausting course of husbandry, and which had never been limed, for it is known that soil never becomes deaf that had been occasionally limed. When the texture was desired to be altered from a stiff to a friable state, or from a very loose to a firmer state, lime was applied. Stiff clay soils were those which were rendered pulverable by lime, and loose gravelly soils were rendered firmer by its action. The most convenient period for applying lime to the land is when the soil had been

* *Prize Essays of the Highland and Agricultural Society*, vol. viii. p. 169.

† *Johnston's Lectures on Agricultural Chemistry*, 2d edition, p. 556.

bare-fallowed; and as that process was extensively practised, the lime was always laid on in summer. It was the most favourite practice with farmers to apply lime in a caustic state, because, being then in a state of finest powder, it mixed best with every sort of soil.

6009. Experience having confirmed all these practices in regard to the application of lime, it is doubtful that many farmers of the present day know more about the nature of lime and its action than what is implied in the above statement, and consequently the practice now is what it was then.

6010. When lime is obtained direct from the kiln, or from shipboard, it is in lumps, called *shells*, and light in weight. Limeshells are differently treated by different farmers in their preparation of it for the soil. Some lay down the shells in small heaps upon the feered ridges, while others lay them in large heaps upon the upper head-ridge. It is clear that the mode of laying shells at once upon the land cannot be adopted until the land had previously been sufficiently fallowed; and as fallowing occupies a considerable time to be done in a proper manner, it is also clear that no considerable quantity of lime can be driven, after the fallow is ready, unless the kilns happen to be near; and, at all events, it is unnecessary to lay the lime upon the fallowed land until only a short period before the wheat is sown. Besides, when shells are placed in heaps on the ridges, they must remain a considerable time there to be reduced to powder by the air, when the lime will have lost a considerable portion of its causticity by union with the carbonic acid of the air, unless a good deal of rain shall have fallen to hasten its slaking. To preserve the shells intact, till needed, they should be put in large heaps, the outer surface of which may become neutralised by the action of the air, but the interior of which will not be so affected. While the heaps are thus occupying a head-ridge, the land may be worked as opportunity offers.

6011. A week or so before the lime is applied, water should be poured on the large heaps of shells to reduce them to a state of fine powder. The water will all

be absorbed by the lime, which nevertheless continues quite dry, thereby indicating that it has been taken up in chemical union with the lime, which then becomes in the state of a hydrate. A great heat is evolved during the time the lime takes to fall to powder; and when it attains that state, the heaps will have swelled to more than three times their former bulk. The lime is then said to be *slaked*, and is in its most caustic state.

6012. While the slaking is proceeding, the land that was manured in drills (4172) is cross-harrowed a double tine, to make it flat; after which the ridges are feered; and the lime is then spread along the feered ridges.

6013. The lime is spread in this manner:—Frying-pan shovels, fig. 233, are the best implements for filling carts with, and spreading lime upon land. A calm day should be chosen for the purpose, but should there be the least wind, the single-horse carts should be so placed at the heaps as that the lime-powder which rises into the air should be blown away from the horses and men. Powdered lime is heavy; but all that can lie upon a shovel is so light in weight that each ploughman takes a heap, and with one of his horses in a cart, for a yoking at a time, fills his own cart, and spreads the lime from it upon the ridges allotted to him. The direction in liming should have the wind a little ahead; and when a number of men take from different heaps, they should so arrange themselves along the ridges as that the cart farthest down the wind take the lead in spreading. In spreading lime, the man walks along the middle of the feered ridge, and casts the shovelfuls right and left from the middle towards the feered furrows, which will become, by ploughing, the crowns of the future ridges. The man who can cast the shovelfuls with either hand will spread lime better than one who is right or left handed only. The lime should be spread *evenly over the surface*; but it may be spread thicker, on one part of the field than another, according to the wants of the soil. On light knolls it may be spread thinner than in hollows, where the soil is either deeper or stronger. Whenever rain falls, the liming should be discontinued.

6014. It is proper to put a cloth over the horse's back and the harness; and the men should cover their face with crape, to save it from the cauterising effects of the quicklime. The horses, whenever loosened from work, should be thoroughly wiped down and brushed, to free the hair of any lime that may have found its way into it; and, should the men feel a smarting in their eyes or nose, sweet thick cream is the best emollient.

6015. Progressively as the lime is spread, ridge after ridge, it is harrowed in a double tine, and mixed with the soil; and immediately on the entire field being limed, the ridges are ploughed with a *light* furrow, to bury the lime as little as possible, and which constitutes the seed-furrow of the future crop.

6016. The *quantity* of lime that should be applied depends on the nature of the soil, the lighter soils requiring the less, and the stronger the greater quantity. On light turnip soils, some think 120 bushels per acre sufficient, whilst I have used 150 bushels with benefit. I have seen as much as 510 bushels applied to the acre of wheat land, with manifest advantage. But perhaps from 150 to 240 bushels may be considered average quantities, from the lightest to the heaviest soils. On weak moory soils, 75 bushels are enough with which to commence its improvement.

6017. The sort of lime should determine the quantity applied, the stronger being used in less quantity than the weak. The English lime is much more caustic than the Scotch. Lime with any magnesia in it is unfit for the land.

6018. It is not customary to apply lime often to land, it being inexpedient to apply it oftener than once in a lease of 19 years, on account of its expense.

6019. Its common price is 3s. per boll of 6 bushels, consequently its entire cost, at the above quantities, will be from £3, 15s. to £6 per acre for the best sea-borne English lime, exclusive of carriage; the Scotch sells for 10s. per cart-load of 4 bolls of 6 bushels each, including carriage for 10 miles, which makes the cost from £3, 2s. 6d. to £5 per acre.

6020. Lime weighs from 75 lb. to nearly 1 cwt. per bushel, which indicates that it ought not to be laid on by the measure alone, but by measure and weight combined, giving the preference to the lightest weight.

6021. Lime is applied at different periods of the year, according to the state of the land. On summer-fallow it is applied immediately before the wheat is sown in autumn. It is also used for wheat, immediately after taking up the potato crop in autumn. It is applied to the land cleared of turnips by sheep, just before the sowing of the barley-seed in spring. It is also applied before the turnip-seed is sown in the beginning of summer. It may be applied to lea immediately before being ploughed for oats in early spring. I do not say it is immaterial to the proper use of lime to choose the season in which it is applied, convenience often determining the point as much as propriety; but experience has decided that it is used to the best advantage on summer-fallow, and after turnips have been eaten off by sheep.

6022. The effects of lime are manifested in a rather remarkable manner. When ploughed down with an ordinary furrow by itself, no effect is observed on the first crop; and when ploughed in deep, a rotation may pass before it shows any effect. When harrowed in, and the land ribbed for barley after turnips eaten off by sheep, it has effect at once. When ploughed with a light furrow above the dung in summer-fallow, even after the lapse of a few weeks it has a sensible effect on the first crop. It has the best effect on the grass of any crop in the rotation, and most upon the clover. It has an injurious effect on the potato crop. It loses its effect on the same land after several repetitions. It has little effect on soils in the neighbourhood of large towns. It has always a good effect on fresh soil, as also on moss that has been thoroughly drained. It has a good effect on all drained soils, and is wasted on undrained ones.

6023. Lime is usually procured in summer and autumn, as the kilns are only kept in activity in those seasons; so when it is intended to apply it in spring, it is necessary to procure it in autumn, and

keep it all winter. And to preserve it in a desirable state in winter, the heaps of shells should be covered with a thick coating of earth, and every crevice that appears in it should be immediately filled up.

6024. I am aware of the opinion of some farmers, that lime is equally efficacious in the soil in the effete as in the caustic state, and Lord Kames was of that opinion; and, therefore, precautions to preserve it in a caustic state in winter may, by them, be deemed unnecessary; but as the general opinion is in favour of quick-lime, and which I support, I have treated the subject accordingly, until experience shall instruct us better. There is the advantage, however, in using quick-lime, that it is much more easily spread upon, ploughed into, and mixed with the soil than effete lime; and if pulverisation be of any use to it at all, it should mix with the soil, and act with it more quickly than in an effete state.

6025. To the ordinary use of lime, as I have described it, chemistry might object to its application so close to farmyard manure as it is in summer-fallow. It is entirely right avoiding to apply it with or near guano, as it will entirely deprive it of its ammoniacal ingredients. But it is not easy to avoid its proximity to manure, when it is considered that it cannot be applied at any time in the course of a rotation, and that a considerable time is required to collect as much of it as will spread over a large space of ground; and that if a large space is not limed when it is applied, time will not be afforded the tenant to lime all his farm, and derive all the advantages from it, in the course of a 19 years' lease. Suppose that he limes the entire fallow-break every year, he cannot go over his farm in less time than four or five years, and this space is as much as he can lime in the course of a year and carry on the culture of the farm at the same time.

6026. If we take the time the farmer has to apply lime, we shall see that he can scarcely avoid applying it near a recent period of manuring. When it is applied on bare-fallow, it must be immediately above the manure; when placed below it, the lime sinks out of reach. When applied to

the potato land after the crop has been lifted, it follows the large manuring the potatoes had received late in spring. The liming land after turnips in spring follows the large manuring which the turnips received in the early part of the preceding summer. When put upon land that has been manured by sheep eating off turnips, it is placed still nearer the manure. Liming land in preparation of the turnip crop in the early part of summer, places it as near the manure. Lime cannot be applied to any of the cereal crops when they are growing, and it cannot be put on grass land that is to be sown or pastured in the same season. Thus, neither in spring, summer, nor autumn, can lime be applied to the soil without coming into near contact with manure; and as to applying it in winter, it is out of the question when a large quantity is to be used. Then rain and snow and frost may prevent its being harrowed in after being spread, and bad weather may prevent the liming proceeding at all after a portion of the field had been limed. After all, as lime is applied only once in a lease, it matters little that it be put upon the land near a manuring; the important point is to apply it at the best and most convenient time, which is on the fallow; and experience has obtained the best return from its use thus, both in grain and straw.

6027. A top-dressing of *chalk* is one method adopted in several districts of England—in Essex, Hampshire, Wiltshire, Lincolnshire, Yorkshire, for affording calcareous matter to the soil. It has a striking effect at first, particularly upon fresh new broken up land; but at length it seems to lose its efficacy. It is applied again whenever its effect becomes inert.

6028. The solid chalk of the lower stratum is preferred to the more porous substance near the surface. It is taken out of pits in lumps, which are put upon the ground to be limed; and, the lumps being wet, the frost in winter causes them to fall down into a powder, which is then spread over the surface of the ground. Dry chalk will not fall down, and is therefore useless for the purpose. Chalk is used in Hampshire to render the soil more loose, and in the wolds of Yorkshire more firm. I would conclude from this that the Hamp-

shire soil is clayey, and that of the wolds of Yorkshire silicious.

6029. The quantities applied vary in different districts. In Essex, in the clay-land district, about 15 cart-loads, of 40 bushels each, are considered a full dressing per acre, at 6s. per load, and 3s. 6d. for carting one mile; but here the expense does not bear carriage farther than four to six miles, beyond which lime is preferred. In Lincolnshire 80 cubic yards of chalk are applied to the acre, at a cost of 66s. In Hampshire it is dug out of pits as deep as 20 feet, and 2000 bushels are wheeled on the land in barrows at a cost of about 45s. per acre. In the district of Windsor, where it has to be carted ten miles, it costs about £8 per acre.*

6030. I have already referred to shell-marl as a manure, in (4999.) The composition of peat shell-marl of Logie, in Forfarshire—a county which at one time afforded and used a large quantity of this substance in its agriculture, to a degree to be positively detrimental to the soil, some of which has not recovered its effects to this day—is as follows:—

	From the top of the bed.	From the bottom of the bed.
Carbonate of lime,	77.6	81.7
Oxide of iron and alumina, . .	1.8	0.6
Organic matter,	14.6	14.6
Insoluble, chiefly silicious matter,	6.0	3.1
	<u>100.0</u>	<u>100.0</u>

Bog-marl retards the ripening of the grain crops, while lime hastens their maturity.

6031. The process of marling as practised in England is very similar to that of gauling or claying, already described in (2119.) The marl is a clay containing particles of chalk, which are quite visible in the mass of clay. The marl is applied both to heavy and light land. On heavy land it is used on new broken up pasture and mixed with farmyard manure in compost. On light soils it is more extensively employed, and its benefits are chiefly derived from an improved texture of the soil. From 40 to 50 cubic yards are applied per acre, at a cost of 7d. per cubic

yard if not driven farther than a furlong, and beyond that distance one penny per furlong is paid. Its action produces better quality of grain and regularity of crop. The excess of organic matter in a new soil loosens it, which the marling corrects; the dry and loose texture of sand is rendered more adhesive and retentive of moisture; and peat is benefited by consolidation and the supply of inorganic matter.†

6032. The following analysis may give a fair idea of the composition of a clay marl. This specimen was found in Ayrshire:—

Carbonate of lime,	8.4
Oxide of iron and alumina,	2.2
Organic matter,	2.8
Clay and silicious matter,	84.9
Water,	1.4
	<u>99.7</u> ‡

6033. The lime used in the agriculture of this country is chiefly derived from the mountain limestone of the carboniferous series, as also that of the coal formation. The rock forms a broad belt across the centre of Scotland, along the centre of England, and in the whole of the centre of Ireland. Lime in Scotland is mostly derived from the coal formation, where it is associated with shales, sandstones, and ironstones.

6034. In Ireland large beds and knolls of limestone nodules, in the form of gravel, are found in many districts. The gravel, when laid upon the land, acts as lime in the course of time; and it affords a very ready means of reclaiming drained bogs, and of reducing their vegetable into earthy matter, (5891.)

6035. The composition of some good limestones for agricultural purposes is here given:—

	Carlisle.	Cockermouth.	Kilhead.	Relig.
Carbonate of lime,	93.91	94.86	95.89	93.97
Sulphate of lime,	0.55	0.23	0.32	..
Phosphate of lime,	1.14	..	..	..
Carbonate of mag- nesia,	2.06	1.26	0.54	1.32
Alumina and oxide of iron,	1.63	0.73	1.20	1.57
Silica,	0.41	2.92	2.05	3.14
	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>

6036. Limestone, on being broken into handy lumps, is packed in alternate layers with coal in kilns and burned, when a very material effect is produced upon its appearance and character. From being a close-grained, hard, heavy stone, it is reduced to a porous, light, splintery cinder. One ton of limestone, when thus burned, yields

* *Journal of the Agricultural Society of England*, vol. iii. p. 183, and vol. v. p. 34.

† *Journal of the Agricultural Society of England*, vol. viii. p. 312.

‡ *Johnston On the Use of Lime in Agriculture*, p. 11.

11 cwt. of the cinder. The cinder is called *limeshells*. The burning has the effect of driving off water and carbonic acid from the limestone; of forming gypsum with the sulphur of the coal, and with the pyrites of the limestone; and silicate of lime with the silicious matter present in the limestone and the coal.

6037. Limeshells have a strong affinity for water: they will extract it from the atmosphere and become in time slaked, which is the end aimed at in putting limeshells on the land in small heaps along the ridges; but they are more commonly slaked by water being poured upon them. The pouring water too quickly upon the shells causes the lime to be gritty, and to contain many small lumps which refuse to be slaked. The spontaneous slaking is attended with the least trouble as usually practised, but in effect it chills the surface and produces much gritty lime; and it gives sufficient time for much of the powdered lime to absorb carbonic acid from the air, and go back to the state of carbonate and become effete. To succeed well with the spontaneous mode of slaking the heaps should be covered with sods, which is a trouble which no farmer will undertake with heaps lying on the field. Farmers will willingly cover large heaps of limeshells that are to remain over winter, to be spread upon the land in spring, by which time most of the lime will be found slaked in an excellent state for mixing with the soil.

6038. In slaking limeshells, an intense heat is produced, a large quantity of water is absorbed, much increase of bulk ensues, and a fine powder is obtained, which is called *quick-lime*, *caustic-lime*, *hot-lime*. The heat in some cases might ignite gunpowder; the lime absorbs about one fourth of its weight of water; it increases from $2\frac{1}{2}$ to $3\frac{1}{2}$ times its bulk; and the powder has strong caustic and alkaline properties. The ultimate results are, that the slaked lime consists partly of caustic lime, partly of carbonate of lime, and partly of hydrate of lime, somewhat in these proportions in the ton:—

	Per cent.	Cwt.
Carbonate of lime,	57.4	11 $\frac{1}{2}$
Hydrate of lime,	{ lime, 32.4 } 42.6 { or	8 $\frac{1}{2}$
	{ water, 10.2 }	
	100.0	20*

6039. The composition of the limes obtained from the limestones mentioned above, (6035,) with the exception of that of Relig, is as follows:—

	Lanarkshire, Carlisle,	Cumberland, Cockermouth,	Dumfriessh, Kilnhead.
Lime,	89.78	89.77	88.64
Sulphate of lime, (gypsum),	1.45	0.38	0.11
Phosphate of lime,	1.93	..	..
Magnesia,	1.69	1.02	0.43
Alumina and oxide of iron,	2.76	1.23	1.98
Silica in the state of silicate,	0.70	4.52	3.39
Carbonic acid and moisture,	1.69	2.68	5.05
	100.00	100.00	100.00†

6040. The purer lime is it is considered

the better for agricultural purposes: it is then said to be in the fattest and strongest state. Of the limes whose analysis appear above, it would seem to me that the Kilnhead is the best for applying to the land. Plasterers like fat lime, as it runs best and makes the strongest putty. When a considerable proportion of sand occurs it is the better adapted for common building purposes, as it then requires less sand to convert it into good mortar, and the natural union of silicious matter is much better than any artificial method of adding it can be devised. Of these the Cockermouth is the best for buildings. Much magnesia in lime is hurtful to vegetation, and is therefore unsuited for the land; but it is a useful ingredient in lime intended for buildings under water, such as piers and docks, where it becomes very hard, and on that account is called hydraulic lime. Of these limes the Carlisle would seem best suited for building piers; but the proportion of magnesia in it is but small compared to many of the magnesian limes of England, as at Hartlepool, where it contains about 45 per cent of the carbonate of magnesia, a ton of which affording no less a quantity of the calcined magnesia of the shops than 9 $\frac{1}{2}$ cwts.

6041. The practice hitherto has been to apply a large dose of lime at once, and not to repeat it during the lease. The motive for this practice I would look for more to the circumstances in which the farmer is placed in regard to the tenure of his farm, than to any reasonable expectation entertained by him of the action of lime upon the soil in large quantity. It is felt with the application of lime as with the draining of the farm—the sooner it is done, and the seldomer done, the greater profit to him who does it. The opinion is gaining ground, however, that it is better for the tenant's interest to lime in less quantity at a time, and more frequently. It would appear, taking the average of the quantities of lime applied in different districts of the country, that about 8 or 10 bushels per acre per annum are applied to supply the supposed requirements of the land. It might, therefore, be better for the crops, and more prudent for the purse of the tenant, to apply 8 or 10 bushels per acre on the fallow every year during the lease, than 160 to 200 bushels per acre at one time at its commencement.

6042. There is no doubt that lime is an exhausting substance for the land. Long ago it was quite common in Scotland for tenants, who grudged to purchase manure, to procure lime and apply it as manure, just as the bog-marl was used, until the land was rendered almost incapable of growing any crop, when it was laid down to grass to rest for a number of years. The various substances of the soil, organic and inorganic, are more rapidly set free after lime has been applied than before; and, on being set free, the roots of plants obtain them the more readily and in greater abundance; and then, as the plants themselves grow more rapidly and to a larger

* Johnston *On the Use of Lime in Agriculture*, p. 44.

† *Transactions of the Highland and Agricultural Society*, July 1848, p. 299.

size, and perfect all their parts more completely, they will carry off a larger quantity of matter from the soil, which, if not replaced in some way, the soil must become exhausted. If more lime is applied to correct the evil, the exhaustion will become the more severe.

6043. Over-liming was an evil which the land suffered in a former generation more than in this; and when it occurred was confined to poor weak soil, that was soon rendered too loose by the use of the plough. It is therefore quite correct what Professor Johnston says, that "the evil called overliming is a mechanical, not a chemical one. The extreme openness of the soil has been brought on by prolonged ploughing, and too frequent cropping of corn. An opposite procedure must therefore be adopted, and mechanical means employed, by which a gradual solidification may be effected," among which none is more effective than the eating off turnips by sheep on the land.

6044. A compost of lime and earth is a better top-dressing for grass land than either separately. Such a compost is usually made too weak of lime: the proportion should be one cubic yard of lime to three cubic yards of earth. The mixing of such a compost costs 1d. per cubic yard of the mixture.

6045. The appearance of the white clover, *Trifolium repens*, on top-dressing healthy soil with lime, is a well-known and remarkable phenomenon. Lime extirpates the corn marigold, *Chrysanthemum segetum*, but it encourages the red poppy, *Papaver Rheas*; and on sinking into strong clay soil it favours the growth of colt's-foot, *Tussilago farfara*.

ON FORMING WATER-MEADOWS.

6046. Several considerations should be carefully attended to ere the formation of a water-meadow is determined on, the principal of which is, whether there be a sufficient supply of water in a dry season to irrigate the meadow thoroughly; and if there be not, the desire for possessing a water-meadow should be abandoned, or its extent confined to suit the water at command. Another important consideration is, whether the water can be spared for irrigation, without depriving other as important purposes of its use, as the thrashing of grain and the watering of live stock in grass-fields. If the water can be used in irrigation before it is wanted for, or after it has been used by, the thrashing-machine, when the water can be conveniently employed for the thrashing power, then it may profitably be employed for irrigation; but otherwise, the advantages of irrigation

would be purchased at a cost beyond their intrinsic worth. A third consideration, of an important nature too, is, whether you have a right to take as much of the water of a rivulet, which may form the boundary of the estate in which your farm is situate, as your water-meadow will require? You can use the water of a brook which wholly passes through your farm as you please, provided it be not injured in its quality, nor directed out of its natural channel when it enters the property below; but you cannot appropriate to your particular use more than half the water of a march burn. If half the water afforded by it is not sufficient for the purpose of irrigation, you should either abandon the idea of forming a water-meadow—for a *dry water* meadow is a vexation in fact, as much as a contradiction in terms—or negotiate with your neighbour for the use of the whole; for it would be a pity to render all the water useless, because either party can legally use only one half of it.

6047. Allowing the quantity of water to be ample for your extent of irrigation, it is better to take it direct from the brook than to erect a dam across it, to collect the water, even though you should possess the power to do so; because, the nearer the bottom of the brook the water is obtained from, the better it is for the purpose of irrigation, on account of the sedimentary matter which it contains; and the more of clay and vegetable matter the sediment consists of, the more richly it will manure irrigated plants. It may cost more to make a channel for the water obtained direct from the brook, than to construct a dam across the same brook, though that is even improbable; for unless a dam is very substantially made, so as to resist the force of the brook under every state of flood, it will cost much for repairs, besides exciting the constant apprehension of blowing from below, or bursting out at the sides.

6048. *Sluices* should be formed to prevent the water reaching the meadows when not wanted, and also to allow one portion of the meadows to be watered at a time, while the other parts are kept dry. All sluices should be substantially and amply built with stone and lime, of which the foundations should be sunk to a depth below that which the water has any chance

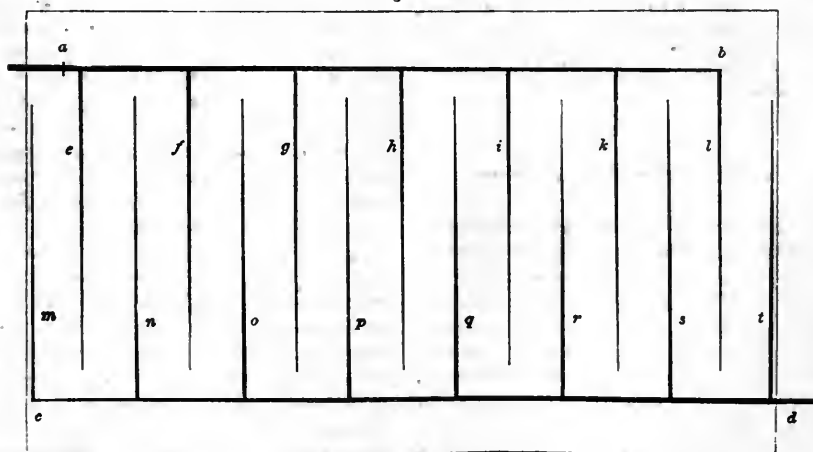
of reaching. The masonry in direct contact with the operating sluice-boards should be formed of droved ashlar. No doubt, sluices of this construction are expensive; but unless the entire appointments in connection with water are constructed in a substantial manner at the commencement, and on correct principles, their repair will be incessant, and use unsatisfactory.

6049. The land to be converted into water-meadows should be thorough-drained, unless the subsoil consists naturally of gravel, which is rarely the case; because, if irrigating water finds its way through the soil to a retentive subsoil, it will remain there in a stagnant state, where no drains are at hand to carry it off; and the consequence will be, the sward of the meadow will in a short time be composed of coarse subaquatic plants, instead of fine meadow-grasses. The best sort of materials for filling the drains of water-meadows are pipe-tiles; and in case the meadow should afterwards be converted into arable husbandry, the drains should be made at least

3 feet deep. The drains should be placed apart at distances corresponding to the breadth proposed to be given to the bed-work of the meadow, that every bed may have the same advantage in regard to drainage. In practice, it will be found that but a very small proportion of the water finds its way into the drains; nevertheless, it is necessary to have a sufficient number of drains to carry off all the water that may find its way into them from any quarter; and, to insure this result, a drain should be accessible from every bed.

6050. These preliminaries being determined, the next business is giving proper form to the water-meadow. Taking, in the first instance, the simplest case of water-meadow, having a very gentle slope from one side to the other of the field, and also from one end of it to the other, the first business is to make the ditch, which is to conduct the water from the brook, to the *highest* corner of the field. Where this water-course or lead enters the field, a sluice *a*, fig. 554, should be put across it,

Fig. 554.



THE BED-WORK WATER-MEADOW.

to prevent the water flowing when it is not wanted. The first operation within the field is to form the *main conductor* of the water *a b* along the upper side, not on a dead level, but with a very gentle descent. It should be made capacious enough to pass as much water as will cover, at one time, the entire surface of the field with running water; and in order to give it the power to overflow at all points

alike, it should be made narrower towards *b*, that, on the water going into the lateral feeders in succession, no more may find its way to *b*, at the termination, than is required to irrigate the ground from that point; and the water ought to flow along the whole of *a b*, as always to have the water at the same height in it. The bottom and edges of the conductor should be made with a uniform smoothness and

inclination. The earth which comes out of the conductor is wheeled away to other parts of the field, to fill up hollows.

6051. The next channel made is the main-drain *c d*, whose province is to carry the water out of the field, after it has served its purpose in irrigation, and, on that account, its dimensions should be exactly equal to that of the main-conductor, but its position and form the opposite at the lowest side of the field. It should also have the same uniform inclination and smoothness down to its largest outlet at *d*.

6052. Whilst these two principal channels are forming with the greatest care and exactness, the intermediate ground of the field should be preparing to be occupied with another species of channels, and the preparation for them is made according to the state of the ground. If the field has been under culture, the ground should be ploughed and harrowed, and the weeds hand-picked, as in summer-fallow, (4165,) and the plough used to gather it into ridges, (749.) The crowns of these ridges are marked by the lines *e, f, g, h, i, k, l*, and they may be at a distance of 30 feet from each other, the breadth of two ordinary ridges of 15 feet. One gathering may probably not suffice, as the crowns should be 1 foot higher than the open furrows. This is all the assistance the plough can give in the making of water-meadows, and the rest should be done with the spade and wheelbarrow; and by their means the channels *e, f, g, h, i, k, l*, are made with a uniform inclination from the main-conductor *a b* to their respective terminations. These channels are called *feeders*, and they occupy the crowns of the ridges, now named *beds*, having a width of 20 inches at their junction with, and at right angles from, the main-conductor *a b*, should they extend as far as 200 yards in length, and a width of 12 inches at their termination. Of similar dimensions are the channels *m, n, o, p, q, r, s, t*, called *drains*, formed in the hollows of the open furrows; because their province is to carry off the water from the feeders, for which purpose they should be formed in the opposite direction, having their widest end at their junction with the main-drain *c d*. These channels being parallel to each

other, and of uniform inclination from end to end, the drains *m, n, o, p, q, r, s, t*, are uniformly 1 foot below the level of the feeders *e, f, g, h, i, k, l*. The soil between them is worked smooth and even with the spade, hollows being filled up, and heights removed to a uniform inclination.

6053. The ground is now ready to be sown with the seeds of the natural grasses, which should always be without a corn crop, to secure a fine and early sward. The following is a good proportion of such seeds, per acre, for water-meadows, for the different conditions of light, medium, and heavy soils:—

Botanical and English Names.	Without a Corn Crop.		
	On Light Soils.	On Medium Soils.	On Heavy Soils.
	Lb.	Lb.	Lb.
<i>Agrostis stolonifera</i> . Marsh creeping bent-grass or florin,	2½	2½	2½
<i>Alopecurus pratensis</i> . Meadow fox-tail grass,	1½	1½	1½
<i>Festuca lolitica</i> . Darnel-spiked fescue-grass,	1	2	3
<i>Festuca pratensis</i> . Meadow fescue-grass,	2½	2½	2½
<i>Festuca elatior</i> . Tall fescue-grass,	1½	2	2
<i>Glyceria fluitans</i> . Floating sweet-grass,	2½	2½	2½
<i>Lolium italicum</i> . Italian rye-grass,	6	6	6
<i>Lolium perenne</i> . Perennial ryegrass,	7	7	7
<i>Phalaris arundinacea</i> . Reed canary-grass,	1	1½	1½
<i>Phleum pratense</i> . Timothy, or cat's-tail,	2	3	3½
<i>Poa trivialis</i> . Tough-stalked meadow-grass,	2½	3	3½
<i>Lotus major</i> . Greater bird's-foot trefoil,	2	2	2
	31½	35½	38

To protect the young plants, 1 bushel per acre of rye may be sown along with the seeds, if sown in autumn, and 1 bushel of barley, if sown in spring. The entire cost of these seeds is 27s. 9d. on light, 32s. 3d. on medium, and 36s. on heavy soils. "When desirable," says Mr Lawson, "the original expense of the above mixture may be decreased from 4s. to 5s. per acre, by excluding the *Alopecurus pratensis*, which is only recommended in consideration of its earliness, and half of the *Lotus major*; under most circumstances, however, it will be advisable to retain the full quantity of the latter, not only from its being the best adapted of the clover tribe for withstanding excess of moisture, but also from its attaining to full maturity at a late

period of the season, when the growth of the grasses generally becomes less vigorous."*

6054. When the field to be converted into water-meadow has been in permanent pasture, the turf should all be carefully taken off, in a handy, well-prepared form, (5746,) and laid aside for use. The bared surface should then be ploughed and wrought with the spade in the manner similar to that described above (6052); and when the ground has been properly prepared, instead of being sown, the turf is replaced, and beaten smooth with the back of the spade. This proceeding makes by far the best finish for a water-meadow, and is, in the end, most economical, inasmuch as the expense of the grass-seeds is saved, and the meadow is ready for taking on water at once, and will yield a good crop of meadow-grass the ensuing season; whereas a meadow sown with grass-seeds cannot be watered with impunity for two years—and even longer, if the grass-seeds had been sown down with a corn-crop. When the turfing of the meadow is finished, the water should be let into the main-conductor, and thence into each of the feeders and drains into the main-drain, and discharged off the field for a shorter or longer time, according as the soil is dry or otherwise, in order to consolidate the soil and the turfing, that any inequality thereby indicated on the surface may be rectified before the turfs have grown together.

6055. This is the simplest as well as the most perfect form of water-meadow; but examples of ground of so much uniformity of surface as now supposed is of so rare occurrence, that modifications must be made in the position of the feeders and drains, to suit the form of the ground. For example, if the ground falls more suddenly from *a* to *b*, fig. 554, than from *a* to *c*, the feeders *e*, *f*, *g*, *h*, *i*, *k*, and *l*, instead of being made on the middle of the beds, should be placed a little towards *a*, the higher part of the ground, making the lower side of the beds broader than the higher, as gravity will easily carry the water down the broader sides into the drains *m*, *n*, *o*, *p*, *q*, *r*, *s*, and *t*. Still, in such a case, the most elevated line of the

beds—their *crowns*—should be formed where the feeders are made, wherever that may be. Should the ground fall suddenly from *a* to *c*, the water will run too fast down the feeders, as made in fig. 554, to avoid which inconvenience, they should go off at such an acute angle from the main-conductor *a. b* as that the water shall flow in them as slowly and uniformly as in the more level case of the ground; and this angle can only be determined by the spirit-level, fig. 493, to which angle the beds should be ridged up, and the drains *m*, *n*, *o*, *p*, *q*, *r*, *s*, *t*, made to occupy the parallel and intermediate spaces at the proportionate lower level (6052.)

6056. Another form of water-meadow is what is technically termed *catch-work*, from the circumstance of a lower set of feeders catching the water in its rapid descent down steep ground, from a higher, thus causing the same channels to act the part of feeders and drains at one and the same time. This is necessarily an imperfect mode of irrigation, and should never be resorted to but from necessity arising from an irreparably irregular form of the ground; so that "to give exact directions for the formation of catch-work," as is well remarked by the late Mr Stephens, "is beyond the ingenuity of man; for no two pieces of land are precisely alike, which renders it impossible for the irrigator to follow the same plan in one field that he has done in another. Each meadow, therefore, requires a different design, and the construction to be varied according to the nature of the ground and the quality and quantity of the water." Impressed with the difficulty of conveying useful information on this sort of water-meadows, I shall only give one supposable case as an illustration of the irregularities that may be found on some grounds; but the expediency of attempting the formation of water-meadows, where the ground is so irregular as to seem unsuited for them, is doubtful. I conceive that the original trouble and expense of making them, and the consequent risk of injuring the ground by an injudicious distribution of the water, would more than counter-balance all the advantages likely to be derived from so imperfect a structure. If

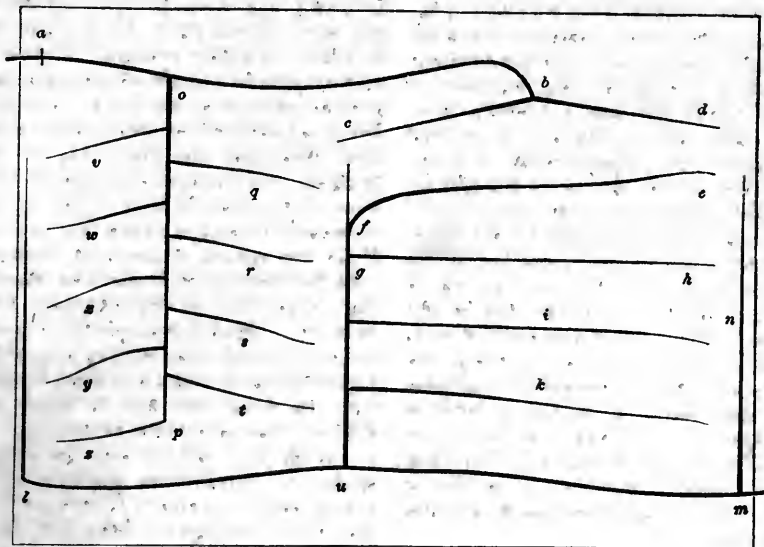
* Lawson *On the Cultivated Grasses*, p. 41, 3d edition, 1850.

the opinion of Mr Stephens, that "the benefit of irrigation depends so much upon the good management and patient perseverance of those who have the superintendence of a water-meadow, that I do

not wonder it has so often proved unsuccessful," is applicable to bed-work, how much more so to catch-work irrigation!

6057. A main-conductor, *a b*, fig. 555,

Fig. 555.



A CATCH-WORK WATER-MEADOW.

is as necessary in catch-work, to convey the water to the different parts of the field, as in the most perfect bed-work; and as it should have the same gradual fall in its course as in that case, it may have to be carried along numerous curves. On the water reaching its extremity at *b*, necessarily the highest part of the ground, it should flow, on the one hand, along the feeder *b c*, and, on the other, along the feeder *b d*, both being true feeders, and not drains. In their overflow the water finds its way to the drain *e f*, which collects all that comes from *c d*; but it is, at the same time, a feeder, and disposes of its surplus water down the descent to *g h*, which in its turn sends it to *i*, and *i* sends it to *k*, which lastly sends it to the main-drain *u m*. Part of the water finds its way to the drain *n*, which conveys it into the main-drain at *m*. Also, the water issues out of the main-conductor *a b* into the sub-conductor *o p*, from which it flows to the right down the feeders *q, r, s, t*; and on the left down those of *v, w, x, y, and z*, to both of which classes of feeders *l u* acts as a main-drain.

6058. It is obvious that the water in *c d* will impart most of its sedimentary constituents to the ground between it and *f e*, and by the time the water has reached *k*, very little foreign matter will be left in it, so that the grass in this upper part of the meadow will be better nourished than that in the lower; but, the sub-conductor *o p* carrying the water from the main-conductor *a b* directly to all the feeders in connection with the main-drain from *l* to *u*, the water will bestow equal advantage to every portion of that part of the meadow. In catch-work, as in bed-work, each feeder may supply water for 30 feet of ground in breadth, if the descent is gradual; but if more sudden, the breadth may be increased to 40 feet.

6059. Where water flows unequally, whether in conductors or feeders, stops are placed in them to retard the velocity of the water. The stops are made of various materials—of pieces of the natural soil left untouched, of pins of wood driven into the middle of the channels, of sods pinned down, of one stone or of stones piled in

heap, and of short boards thrust into the edges of the channels at an angle. In all cases of regular bed-work, fig. 554, the surface being uniform in its descent, no stops are necessary, nor are they required even in catch-work, where the water flows direct to an overflow, as in *b c* and *b d*, fig. 555; but where water is supplied down the steep sub-conductor *o p*, they are requisite to guide it equally into the entrance of each of the feeders *g, r, s, t, and v, w, x, y, z*. But all the kinds of stops just enumerated are objectionable, because pins collect straws and sticks brought by the water; stones and turfs cause holes to be formed in the channels by the water falling over them; and notch-boards injure the edges of the feeders, besides causing deep holes by the fall of the water over them. The best form of stops consists of a piece of wood forming two wedges with their bases united; because, when placed firmly to the bottom between the edges of a conductor or feeder, the water flows over them in an unbroken mass, with a retarded velocity. A number of such stops of unequal breadth fit any size of channel.

6060. Where the natural fall of the ground admits of the arrangement, it is quite possible to convey the water in a lead from the lowest main-drain of one water-meadow to the main-conductor of another at a lower level; but, as the water would then be almost deprived of its manuring properties, where there is a large supply of water, it would be better to convey it at once to the lower meadow; and where there is no surplus water, liquid-manure should be put into the lead, and the water, as it left the one meadow, could carry it by the main-conductor to the other. In my opinion, liquid-manure would be much more profitably applied in this way than by direct sprinkling on the soil, as the extraordinary effects produced by the foul-water irrigation in the neighbourhood of Edinburgh fully demonstrate.

6061. The expense of converting land into water-meadow varies according to circumstances, and is often very great. Where the ground is nearly level, and the surface covered with turf, the turf may be taken up, the ground properly shaped, and the turf replaced for £3 per acre, as was

instanced in one case belonging to the late Sir Charles Stuart Menteth of Closeburn, in 1826; whereas, in a case of Mr Lawson of Cairnmuir, in Peeblesshire, the cost was £12 per acre. In one case it cost Mr Simpson of Glenythan, Aberdeenshire, about £7, and in another case only 36s. 9d. per acre. From £7 to £9 per acre may be taken as a fair average. Unless the advantage to be derived were considerable, such an expense would not be justifiable; but in all cases where meadows have been well managed, the yield has at least doubled; and the land that was not worth more of rent than from 5s. to 15s. an acre, increased in value to nearer £3 per acre. From the nature of the work connected with their formation, it cannot be otherwise than expensive, as Mr Stephens justly remarks: "However simple the construction of a water-meadow may appear in a superficial view, those who enter minutely into the detail will find it much more difficult than is commonly imagined. It is not an easy task to give an irregular surface the equal slope requisite for the overflowing of water. It is very necessary for the irrigator to have just ideas of levels; a knowledge of superficial forms will not be sufficient. Few people unacquainted with the art of irrigation, and the regularity of form which the adjustment of water requires, have any idea of the expense of modelling the surface of a field."

6062. Great as are the benefits derivable from water-meadows in the low country, such meadows would prove of incalculably more advantage to our Highland districts, where hay is the most valuable food for stock in winter that can be raised at such altitudes. That the formation of water-meadows is quite practicable in all our Highland glens is apparent from these sentiments of Mr Stephens, with which I cordially acquiesce, and earnestly press upon the consideration of such of you as may betake yourselves to hill-farming. "Fallaws-meadow, on Sir George Montgomery's large sheep-farm, containing 15 acres, was enclosed from moorland in 1816, and, by collecting the water from the surrounding sheep-drains, 5 acres are partially irrigated, and the remaining 10 are top-dressed with the manure made from part of the produce, which is consumed in winter by the sheep of the farm in a wooden shed near the meadow. By this simple method of improvement, 15 acres of common sheep-pasture land gave the proprietor from 3500 to 4000 stones of hay per annum, averaging 6d. per stone. In that year of drought, 1826, the hay of this meadow was sold from 1s. to 1s. 3d. per stone. What an immense advantage to a

sheep-farmer! By this simple process of enclosing and cutting a few small feeders and drains, the owner is enabled to provide food for his flock, when his less fortunate neighbours' sheep must either starve or be supplied from the farmyard; but I am afraid there are few sheep-farmers who are so fortunate as to have any hay over and above what is requisite for stock at home. Sir George fed the same number of sheep on the farm as he did before the meadow was cut off and enclosed, and I am fully persuaded that the same improvement might be made on almost every sheep-farm in Tweeddale; for, in almost all of them, there are situations where 5, 10, or 15 acres might be enclosed and partially irrigated, as in every pastoral district there are numerous rills which might be easily collected, and used to the greatest advantage, at a very trifling expense; so that, instead of being obliged, in snow-storms, to send 50,000 sheep to a milder climate of the southern parts of Dumfriesshire, where the owners are obliged to be at the mercy of their southern neighbours—not to mention the very serious injury the flocks receive by so long and fatiguing a journey—by adopting the above system of improvement, a considerable portion of the losses generally sustained would be prevented,* (1027) and (1041.)

ON IRRIGATION.

6063. "At the beginning of the month of October," says Mr Stephens, "each feeder and drain should be cleansed, and the banks of the feeders repaired where they have received damage by the treading of cattle." A thorough repair of this sort every year will cost about 9s. per acre.

6064. "The whole works being repaired, and there being generally water enough at this season either for the whole or for part, the sluice should be drawn, when, in the course of half-an-hour, the conductor and the upper part of the feeders will be nearly filled. The first operation of the irrigator is to adjust the water in the conductor; or, if the meadow is in more parts than one, the water in each conductor must be first regulated. Then he commences anew, by regulating the stops in the first feeder; but should there not be sufficient water in the feeder, a little more must be let in, by making the aperture wider or deeper, till the water flows regularly over the sides from one end to the other. From the first he proceeds to the second feeder, and so on, until the water

in all the feeders is adjusted. Let the beds of a water-meadow be ever so well formed, yet, by some places sinking more than others, or by the ice raising the surface of the ground, although the water along the banks of the feeders has been ever so nicely adjusted, it often happens that there may be some places between the feeders and drains with too little water, when it will be advisable for the manager to make a third round, redressing inequalities of the surface so as to give *every spot 1 inch deep of water*. Every part of the works being regulated, the water should be allowed to run through the whole of October, November, December, and January, from 15 to 20 days at a time without intermission. At the expiration of each of these periods, the ground should be made completely dry for 5 or 6 days, to *give it air*; for there are few species of the grasses which form the most nutritive part of the herbage of water-meadows, that will long exist under an entire immersion of water. Moreover, if the frost should be severe and the water begin to freeze, the *watering must be discontinued*, otherwise the whole surface will become one sheet of ice; and *whenever the ice takes hold of the grass, it will undoubtedly draw it into heaps*, which is very injurious to meadows. The object of this early watering of the meadows is to take advantage of the autumnal floods, which bring along with them a variety of putrescent matter, which is found very enriching to land. It is the chief object of the irrigator, in those months, to collect as much of this manure as possible, and at the same time to shelter the land from the severity of frosty nights. It is therefore requisite to *use as much water as the land will carry without guttering*. I believe it would be difficult to give land, with a dry subsoil and considerable descent, too much water before the weather begins to get warm. It is necessary, in those months, that the meadows be inspected at least once in 3 or 4 days, to see that the equal distribution of the water is not obstructed by the accumulation of weeds," &c.

6065. Simple as these directions are, the actual management of the water of meadows is not unattended with difficulty,

* Stephens' *Practical Irrigator*, p. 82.

and requires the exercise of considerable judgment and great attention. "The adjustment of water flowing over the surface of land," observes Mr Stephens, "for the purpose of improving the herbage, is a *very nice operation*; it requires a perfect knowledge of levels and the vegetation of grasses, and *ought never to be intrusted to an unskilful manager*. When the supply of water is, in any state of the stream that supplies it, sufficient for the whole or one-half of the meadow at once, the management becomes pretty easy; for after the works are cleaned, and the water regulated in the autumn, the sluices should be fixed at such a height as to let in the exact quantity of water required, when it is allowed to run, according to the state of the weather and the season of the year, for 2, 6, 10, or 15 days, without any alteration; and it will be found (unless the water has carried along with it weeds, sticks, or wrack of any kind) to run during that whole period nearly as equally over the surface as when first put on. But when the stream is small, and rising and falling with every shower of rain, the management becomes so much the more difficult, that it will require every possible attention of the irrigator to watch and change the water from one part of the meadow to another; or from one bed to another, according to its abundance or deficiency. *Such meadows are indeed ill managed, although half-an-hour's work in a day would put every thing to rights*. Indeed, let the formation of the meadow be ever so perfect, and the supply of water constant and uniform, yet it is necessary that the manager should survey the whole every 3 or 4 days, to remedy any defect occasioned by the accumulation of weeds, or by a stop being washed away, and thereby cause some places to have too much water, and others too little; so that, in the former case, the grasses might either be killed or very much injured by the generation of scum, or, in the latter case, there would be little or no product of grass. Small streams are certainly much more at command than large; but if the manager, as is too often the case with a young practitioner, vainly endeavours to water too much ground at a time, he may give one part too much water, and

another too little; for on the alteration of the apertures, and adjustment of the water, greatly depends not only the quality but the quantity of the crop."

6066. There are many ways of *mis-managing* water-meadows, such as retaining a moist subsoil, or allowing the grass to stand too long before cutting; but there is an error committed at this period of the year, to which I wish to direct your attention, and which is thus characterised by Mr Stephens. "Another great error generally committed is, allowing the water to run too long at a time, without properly *drying* the ground. I know some instances where the ground is not attempted to be dried from the time the water is put on the meadows in autumn till 8 or 10 days before the cutting of the hay; the consequence is, that the grass is of the coarsest quality, and the ground becomes so very boggy that the whole crop of grass is obliged to be carried by people to some other place, to be made into hay. . . *All dry soils require more attention than moist ones*; for, if the water in moist soils should not be so nicely regulated as on sandy or dry land, the crop of grass will *not* be so defective as on *porous soils, where the management has been neglected*. I presume that all dry land that has been converted into water-meadows, in countries where the art of irrigation is not well known, and the supply of water not abundant or regular, is liable to more injury, from imperfect treatment, than land of a moist nature; for plants must have their food at stated times as well as animals, but *this cannot* be the case when the water is irregularly applied."*

6067. It is the practice of some, that when a deficiency of plants is observed, in a meadow that had been made from old pasture, to allow the grass to shed its seed in the ensuing season in order to thicken the sward. This should never be done, because very many of those plants which have shed their seed will die out. An idea much prevails, that, because pastures are permanent, the lives of the grasses which compose it are permanent also; but the fact is otherwise. Most of the grasses are perennial, but not permanent;

* Stephens' *Practical Irrigator*, p. 20-7.

and we do not know the longevity of the decidual plants of grass which constitute a permanent pasture, though observation would instruct us, that on permanent pasture the older plants die out and young ones take their place. For aught we know, then, in regard to the age of any portion of a permanent pasture, that the one we have selected for shedding its seed, for the purpose of filling up gaps, may be the very one which contains the oldest plants, which will die out after having shed their seed. The sure course for the owner of a water-meadow to pursue, when he desires to fill up the gaps of grass in it, is to sow the bare spots of earth with new seed, which will assist the grass to cover the ground entirely, instead of imposing upon the existing plants the exaction to fill up the gaps for him.

6068. The returns from irrigation are surprising, even from unpropitious circumstances. Mr Simpson of Glenlythan in Aberdeenshire tells us, in regard to the state of the ground which he converted into water-meadow, that, "previous to the ground being operated upon for the purposes of irrigation, the burn ran through the den in a winding course. The ground, at the top of the den, consisted of a few mossy hillocks; and the other part of the ground was pretty level, of a dry nature, and covered with a short grass. The ground was never cropped with grass, and the grass was not in use to be cut. The cattle were occasionally turned out upon it, when pasture was scarce in the other parts of the farm. The soil, generally, except the mossy part, is alluvial in some places, and at others gravelly." There are many such places as this in Scotland, that might be converted into water-meadows where there is a command of water.

6069. After irrigation from November 1843 to the beginning of May 1844, this meadow was cut for the first time on the 14th of June following, and was continued to be cut until the October of the same year. In November 1844, irrigation was again commenced, and continued until April 1845. In both summers, after the meadow had been cut in portions, the

water was let upon each for a few days at a time.

6070. The produce in the two seasons was as follows from the same piece of ground:—

	1844. Cart-loads.	1845. Cart-loads.
Cut in June,	12	13
... July,	32	36
... August,	34	43
... September,	30	42
... October,	11	8
	<hr/> 119	<hr/> 142

Each cart-load of grass weighed 6 cwt., and the load that was made into hay in 1844, by way of experiment, yielded 2 cwt. 104 lbs.; so that the 4 acres, 1 rood, 38 poles of meadow would have yielded 2788 stones of hay of 14 lb. to the stone, or 652 stones per acre, which in 1845 was increased to 778 stones=495 stones of 22 lbs. to the stone, the ordinary method of estimating the weight of hay in Scotland. Estimating the 495 stones of hay at 6d. each, the value amounts to £12, 7s. 6d. per acre, or £52, 17s. 6d. over the whole ground, being £21, 9s. 3d. more than the ground cost to convert into a water-meadow.*

6071. As it is impracticable to irrigate meadows in winter in highland districts, that process should be delayed till every chance of frost has subsided—until May, after which there will still be sufficient time for a crop of natural hay to grow, be cut down, and won, before the departure of summer. Such a meadow is useful in a backward spring for the support of ewes and lambs; and the sheep belonging to Sir George Montgomery would have inevitably perished in the cold and backward spring of 1826, had it not been for the grass afforded by a water-meadow from the middle of April to the beginning of May; after which latter period the meadow was irrigated, and produced nearly 300 stones per acre. The attention of hill-farmers cannot, therefore, be too strongly drawn to the subject of water-meadows. Any attempt to irrigate meadows in such situations in winter, and to pasture them in early spring, would but injure the meadow by means of frost, and, at the same time, rot the sheep; but sheep may be pastured, if necessary, in perfect safety on dry meadow-land in spring, and the meadow, on being afterwards irrigated, might yield a good crop of hay.†

6072. The mode in which water acts, in producing the effects witnessed in water-meadows, has not yet been satisfactorily ascertained. It is not the sediment in the water that alone pro-

* *Transactions of the Highland and Agricultural Society, July 1847, p. 44-8.*

† *Stephens' Practical Irrigator, p. 82.*

duces the effect, for clear water produces similar effects ; though, no doubt, enriching ingredients carried by the water encourage the growth of plants more rapidly than clear water. Professor Low has these observations on the theory of the process. "The theory of the process of irrigation has not been satisfactorily explained. That the effect is not produced by the mere supply of deficient water, appears not only from the period at which the water is admitted, and when in our climate the soil is always saturated with the fluid, but from the circumstance, that the effect is not produced when the water is allowed to stagnate, and sink down in the soil, but when it is kept in a current over it. When the water is suffered to stagnate, the soil tends to produce carices, junci, and other sub-aquatic plants ; but when it is kept in motion, and drained off at intervals, the finest grasses peculiar to the soil and climate are produced. Neither does the fact of the deposition of mud, or other fertilising sediment, explain the phenomenon ; for however such depositions may increase the effect, it is likewise found that water, without the least perceptible sediment, may be employed with success. It has been supposed that the water acts beneficially, by maintaining the soil at a higher temperature. Water, at a temperature of 40° is of greater specific gravity than at a lower temperature ; and hence, as the water tends to the freezing point, the warmer portion of it is next the ground. Much, therefore, cannot be ascribed to this cause, in a current so shallow and constant as that which passes over the watered meadow. It is probable, therefore, that the main effect is produced by a mechanical action of the water, acting upon and bringing nourishment to the fibrous roots of the plants."^{*}

6073. The late Professor Rennie, of King's College, London, explained the phenomena of irrigation by reference to the excretion of plants. He supposed it to be probable that every species of grass is not alike affected by its own or the excretory matters from other grasses, and therefore some species withstood the poison better than others ; but that the water of irrigation, in its descent through the soil, washed and carried away this matter, and on thereby cleansing the soil they grow the more freely by it. Hence the perennial verdure of irrigated meadows (5107.) †

6074. Sir Humphry Davy's opinion was, that "in the artificial watering of meadows, the beneficial effects depend upon many different causes, some *chemical*, some *mechanical*." ‡ Now, chemical action only commences after the act of irrigation has ceased. No doubt, the effects of the substances, whatever they may be, which are deposited by the water of irrigation, may be chemical, as well as those are of manure applied to grass by the hand of man. But the act of the water, in depositing fertilised materials, can no more be chemical than that of the instruments

used in spreading dung upon the soil. The fact seems to be, that whenever the water of irrigation, or the substances contained in it, act *chemically* upon the grass or soil, while subjected to the process, that instant irrigation proves injurious to the plants ; and the injury is evinced by the existence of a white scum floating upon the water, which is generated when the water has been too long retained upon the grass in a state of the atmosphere tending to too high a temperature for the season.

6075. I proposed, some years ago, a conjunction of the two theories, mechanical and excretory ; and the compound theory seems to explain these four great points in irrigation, namely, that it supplies moisture to the soil in dry seasons and in tropical climates ; it affords protection to plants against the extremes of heat and cold ; it disseminates manure in the most minute manner to plants ; and it washes away injurious matter from the roots of plants. The benefits derived from irrigation I therefore maintained, are purely mechanical. I stated the case in these terms :— "The operation of water bringing matter into minute subdivision ; the sediment which it contains when used in irrigation being minutely distributed around the stems of the plants ; water protecting plants in irrigation against the extremes of heat and cold, by completely covering and embracing every stem and leaf ; and the supplying of moisture to the soil and washing excrementitious matter out of it, are all purely mechanical operations." So that, "*could the hand of man distribute the manure around the roots and stems of grass as minutely and as incessantly as turbid water ; could it place a covering of woollen texture upon each blade and around each stem of grass, to keep it warm, as completely as water embraces each plant ; could it water the grass as quietly and constantly as the slow current of irrigation ; and could it wash away hurtful matter from the soil as delicately from the fibres of the roots of grass as irrigating water, there would be no need of irrigation ; the husbandman could then command verdant pasturage for his flocks and herds throughout the year, and in the driest season ; his mechanical agency would be as effective as irrigation : but, as the relation stands at present between man and the action of physical laws, he employs irrigation as an instrument of his will, and induces nature to assist him in maintaining his live-stock by her peculiar mode of acting, in which she undoubtedly displays in this particular, as in every other thing, her superiority over him, both in perseverance and dexterity."*

ON THE TREATMENT OF DRAUGHT STALLIONS.

6076. We have now considered every

* Low's *Elements of Practical Agriculture*, p. 470, 4th edition.

† *Quarterly Journal of Agriculture*, vol. v. p. 24.

‡ Davy's *Agricultural Chemistry*, p. 305.

§ *Encyclopædia Britannica*, 7th edition—art. *Irrigation*.

subject connected with the culture of the soil. It now remains to attend to some particulars relating to the treatment of live-stock, which only present themselves to notice occasionally, but which nevertheless are as incumbent on you to become acquainted with as with the more common proceedings of the farm. One of the subjects to which I allude is the treatment of stallions. For all the foals that any farmer requires to rear in any year, in order to fill up the blanks that may be occasioned by death amongst his draught horses, he would never require to keep a stallion for the use of his own mares alone; but whenever a superior colt foal is dropped by a mare of superior quality, he may be induced to rear it as a stallion, notwithstanding the trouble which it may impose upon him, the danger involved in keeping it about the steading, and the expense incurred in maintaining it in the condition it ought to be. Taking all these points into consideration, very few farmers rear stallions; they prefer engaging the services of one which travels the country, with an owner who makes it his business either to breed them, or to purchase an entire colt likely to turn out a good stallion.

6077. But supposing you wish to rear a stallion, it is necessary that the colt should possess such properties as to render it probable that it will become a good horse. A foal does not present many of the points found in a good horse; but as it is kept until a year old before being castrated, time is allowed to show whether or not it is likely to possess the requisite points.

6078. However many good points a colt may possess, if one or more of the following diseases be indicated it should be rejected as a stallion—namely, contracted feet, founder, sand-cracks, ringbone, bone-spavin, curb, bog-spavin, diseases of the eye, broken wind, roaring, wind-sucking.

6079. When a colt with promising appearances is determined to be kept as a stallion, it should be placed under the care of a man who will work and attend upon it at all times. While the stallion is young, say 1 year old, it should be bridled in spring, and taught to be handled and led, and in summer get a run on good grass, in company with colts. The next

winter it should have a loose-box to itself, as *u* in the work-horse stable O, Plate II., or a loose-house, and supported on the best food, prepared for it according to the directions given in (1431.). Next spring it should be broke in by an experienced horse-breaker, and taught to work; and although its work should never exceed its ability, in case its shape should be injured, a little of it, even at an early age, encourages the growth of bone and muscle, and renders a colt more easily handled and commanded. In spring, when in hands, it may be exhibited at a show as an entire 2 year-old colt, to assist in making it known, if its figure be good; if not, it had better be castrated at once. A run at good grass, for a couple of months, after this discipline, in a securely fenced field, in company with colts, is of great service; but if the fences are not trust-worthy, it should be supplied with cut grass in one of the hammels or courts. When thus confined, everything loose should be removed from the court or hammel, that it may not blemish its legs by an accidental stroke upon them. In the following winter it should be supported on the best food, in a loose-box (1557;) and towards spring be well kept, groomed, and clothed, to keep it clean from dust; and regularly exercised, to put it in high order and condition by April, in time to be exhibited for a prize. When at this age, not exceeding 3 years, it may appear leggy, and want middle in comparison with older horses, and may therefore be defeated in competition; but if it have a good shape and well-balanced quarters, it may get a few mares to serve; and should it obtain a district by a premium, it should not serve beyond the allotted number of mares. Many farmers object to a 3-year-old stallion serving at all; and, in ordinary circumstances, it is better to refrain from service until next year, when as a 4-year-old it will be in great vigour, and display great increase of substance.

6080. When a stallion undertakes to travel a district as a premium horse, or on its own account, it should be provided with a sheet and roller, with a light wallet strapped across its back containing corn and beans, a few cleansing instruments, such as curry-comb and brush, water-brush and foot-pick, mane-comb and

sponge, figs. 116 and 310. Besides a bridle with a curb-bar, to keep it in check, it should be provided with a stall-collar and water-chain, to fasten it at night in a stall when a loose-box cannot be had. Its shoes should be light, and, to be durable, they should be *steeled* in the fore-bits and heels—the former being only a thickening, and the latter a little turning up of the outsides. The shoes usually worn by stallions are very clumsy, and, in case of excited action, are apt to cause tramping, (1546) to (1556.)

6081. It is too much fatigue for a man to walk with a stallion in all his journeys during a season, the only remedy for which is a pony gelding to ride upon; but should the possession of a pony induce him at any time to trot the stallion along the hard road, to make up for time spent in his own indulgence, or to overwalk it in too long journeys, the man who so far forgets his duty should either be dismissed or caused to walk; and be forbid to mount the horse's back. If the leader has a proper idea of his work, he will divide the district so as to go over it all in regular order in the time a mare would come again into heat should she prove not in foal. He should keep a book and enter the services of the horse day by day, not merely as a memorandum, but as a detailed document, by which to make up his accounts correctly, and, in case of dispute arising from alleged negligence of service, to prove the regularity of his attendance. I have witnessed disagreeable disputes arise from the leader neglecting to keep an account of the services of the horse.

6082. It is customary, when the farmer affords a night's quarters, to do so gratuitously, and even supply the corn; but unless otherwise arranged, the understanding is that the man supplies the corn and beans from his own store. A stallion in its travels requires at least 5 feeds or 1 stone of corn a-day, with a proportionate quantity of beans, at 5 separate times. It should always rest at noon. It should be supplied frequently with water during the day. Whenever it halts, its skin should be wiped and brushed, and its tail and mane combed. Every night it should have its feet searched with the foot-pick, and washed clean with the water-brush

and sponge; and should they feel hot and hard when travelling in dry weather on dusty roads, a stuffing of cow-dung and clay forms a nice cooling poultice. A bran-mash at night, twice, or at least once a-week, on Saturday night, with 1 oz. of nitre, proves an excellent alterative. Its litter should be ample to encourage it to lie down and rest at night. It should always be borne in mind to give its food at stated hours every day, along with the conviction, that it is its food alone which enables the horse to maintain its condition, and consequent spirit, on its very exhausting travels. A stallion that loses condition and spirit to a considerable degree on its travels—one, in short, that wants bottom—is unworthy of serving draught mares, for its progeny will assuredly prove as soft as itself.

6083. The number of mares limited to a horse which obtains a prize is commonly 60, at 1 guinea a mare; but the number is seldom adhered to, because many farmers, instead of paying the guinea, make a bargain, offering less money, or only agreeing to pay even the lesser sum, should the mare prove in foal; and to secure a good season, the leader of the horse agrees to the terms, and makes up the gross *sum* he is entitled by the rules of competition to receive, by either taking more mares than the stipulated number, or by travelling beyond the district, or by doing both; and he is blameless under the temptation. In this, as in many similar matters, farmers are shortsighted, in attempting to save a few shillings, they run the risk of losing a foal, by making their agreements on such conditions as *compel the horse to be overworked*. The owners of horses which fail of obtaining a prize choose districts for themselves, and bargain for any amount of fee; and it is their conduct which some farmers use as a means to beat down the fee of the prize-horse.

6084. The mode of putting a horse to the mare will be found in (3676,) (3677,) and (3678.)

6085. When the horse's season has terminated, from the beginning of April to the end of June, it will be found to have lost much condition, and no small share of spirits. It should be immediately put

in fresh though not in high condition, and an excellent means of doing so exists at that season on the cutting grass, which is daily in hands, (3869.)

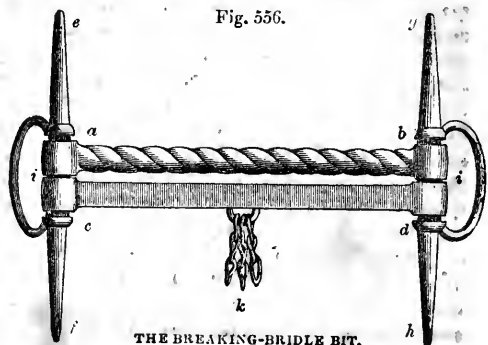
6086. Some owners object to working stallions out of the season, and when they have been ill broken-in, and not handled when young, and are therefore easily excited and put out of temper; it is proper to refrain from working them; and some horses have naturally an ungovernable temper, that are not safe to put into the yoke; but whenever a stallion is quiet and obedient, work is of use to itself, in giving it exercise and food regularly, and inducing it to rest at night. According as the animal works best by itself, or in company with another horse, it should be treated. Perhaps single-horse carting is the work most compatible with its temper and strength to be put to most constantly, though its loads ought to be comparatively light to its strength and willingness. At whatever work it is employed, much of the quietness and good temper of the horse depends on the temper and judgment of the person who leads it.

ON THE BREAKING-IN OF YOUNG DRAUGHT HORSES.

6087. Young draught horses are never *broke in*. They are most frequently yoked with an old steady horse at once into the harrows, accompanied with a few restrainers of reins and ropes, or an additional hand or two to assist the ploughman to prevent any attempt at a run away; and no doubt, when colts have been haltered and led about from the time they were weaned, by a steady quiet-tempered man, they will soon submit to work, and become quite tractable in the course of a few short yokings. But, notwithstanding their quietness, they cannot be said to be *broke in*; in the proper sense of the term—that is, they do not yield to the guidance of the ploughman because they know or understand what he means, but simply because they feel they are obliged to move along with an older and a stronger horse, to which they are attached, as it may choose to lead them. Their mouth is quite

insensible to the rein all the time they are apparently tractable; they seize the bit with their teeth, and press upon it, with their head hanging down, their neck arched, and their eyes set back, as if suspicious of an advantage being about to be taken of them. In this position, in every yoking they are worked they look liker objects of oppression and pity, than of exultation to the farmer, while witnessing the young noble steed he has bred and reared undertaking its first work. In the end, the dull sulky-looking colt is confirmed in his natural doggedness, and the timid one rendered more afraid. No doubt, time brings about a change; but why should the change be allowed to be effected by lapse of time, to the discomfort and annoyance of the animal, when it might do his work with comparative ease by being broke in?

6088. The easiest plan to make a draught-colt soon work well is to employ a good horse-breaker to bridle, and handle, and lunge him—as long as is requisite to make its mouth yield to the bit—and then it will obey both voice and rein; and while employing the rein, the horse-breaker should be instructed to use the language that will be spoken to it while at work, (687) to (694.) The harness required for this purpose is a breaking-bridle, a cavesson, and pad for the back, all which the horse-breaker brings with him. Most of the bits I have seen used in breaking-bridles seem to me inefficient for the purpose. They are thick at the guard, round, and jointed in the middle—a construction which gives the horse an opportunity of seizing them with its teeth, when folded back against the sides of the mouth, by the force of the reins acting on



the rings. A much better bit, in my opinion, is represented in fig. 556, which I have seen used many years ago in Berkshire, by the late Thomas Middlemiss of Northam, who was reckoned in his day one of the best horse-breakers and grooms that had practised his useful art in that part of the country. It consists of two bits, one twisted and the other square, both $8\frac{1}{2}$ inches in length. The square bit $c d$ is half an inch square, and so is the diameter of the twisted one $a b$, and they both have a play of half an inch between the shoulders of the guards $a c$ and $b d$. The guards $e f$, and $g h$, are 7 inches in length. The ring i on each side is $2\frac{1}{2}$ inches in diameter over all, and at k is a bunch of links to lie upon the tongue, and make the horse move its jaws. The straps connected with the bit are the *head-stool*; the *hand-reins*, $4\frac{1}{2}$ feet in length; the *cheek-reins* to keep the horse's head in line when strapped to the pail, and which pass below the neck-strap of the martingale. These three straps are buckled by their ends to the rings $i i$. A *martingale* is necessary to prevent the head being thrown forcibly up. The breadth of the straps is 1 inch; that of the counter-strap of the martingale $1\frac{1}{2}$ inch. The bit can be buckled on in the reverse order shown in the cut, having the square bit $c d$ uppermost, and the bunch k is then screwed to the twisted bit $a b$. The cavesson is well known, its figure and appointments being uniformly the same.

6089. It is unnecessary to go through all the discipline of breaking in a draught colt, as is required in the case of a saddle-horse. The playing of the mouth with the bit for 2 or 3 hours in the stable, twice or thrice a-day, the colt standing in the reversed position in the stall, has the double advantage of making the mouth yield to the bit and of keeping up the horse's head. The bit is buckled on slack for this purpose, so as to lie upon the bare spaces of the gums of the lower jaws between the front and back teeth, where the square or twisted parts of the bit rub sharply; while the bunch of links k makes the lips and tongue play as if desirous of getting quit of the whole constraint. When the head is pressed forward to get hold of the bit with the back teeth, the straps, being too long, prevent them doing

so; while the bunch k lies too far forward upon the tongue to be agreeable. After this discipline in the stable for two or three days, with occasional walks out of the stable, according as it is seen that the colt yields to the bit, it is led out to *walk* two or three hours at a time by the nose-rein of the cavesson, to learn to step out, and to acquire a good pace; and walking is the most useful pace for a draught-horse. A short lunge backwards and forwards round a circle, on red land, will be useful, not to teach him to trot; but the trotting action makes him more active, and sooner gives the use of his legs in cases of difficulty. It should then be backed, and, while guided by the reins, should be spoken to in the language it will be addressed in the yoke. After that, it should be guided along a road with long double-reins, while carrying the plough harness, to accustom it to the noise and to feel the motions of the plough chains. Now all this discipline may be gone through in the course of a week, or 8 or 10 days, according to the disposition of the animal, the handling he may have received since he was a weaned foal, and the skill of the horse-breaker. The degree of exercise given should be with a discrimination suited to the condition and physical strength of the animal. The horse-breaker should groom the colt immediately after exercise, that the animal may become familiarised with the usages of the stable. The colt's food, too, should be so administered as to harden his condition for labour, with the understanding however, that, after the busy season of work is finished in the early part of summer, the young tyro shall be allowed to have a run at grass for a few weeks, and then fall in to take its own share of the regular work.

6090. After such treatment and discipline from the horse-breaker, the colt will be easily made to understand work. The sort of harness in which it is first invested is that of the plough, (676) to (685.) It is quite possible that the breaking received from the horse-breaker will make the colt suffer at once to be yoked with an old horse to the plough; but in case of accidents, and to err on the safe side, it is best to use precaution, and the principal precaution is to attach it to a

strong steady horse, that will neither bite nor kick it, and yet be able to withstand the plunges the colt may choose to make. The attachment is made by a cart-ropes being first fastened round the girth of the old horse, and then passed round that of the colt, leaving as little space between their bodies as is required for ploughing; and to afford no liberty to advance or retire beyond a step or two before or behind the old horse. Beside the usual rein employed by the ploughman, the horse-breaker should have another in his hand from the colt's head. Thus equipped in plough-harness, the first yoking of the colt should be to an old cart-wheel, placed on its dished face on ploughed land, furnished with a swing-tree, with which it should be made to draw it, while the horse walks beside him; and on drawing this, the reins should be used, and the appropriate language spoken, that he may associate the changes of his motions, which are indicated by the reins while guiding him, with the accompanying sounds. Should the colt offer to turn round, the gentlest means should be used in putting it again in its proper position, as the start may have been made from fear, or from the tickling of a part of the harness. When a hind-leg gets over a trace chain, the chain should be unhooked from the swing-tree, and hooked on again after the colt has been put in its right position, and the leg not attempted to be lifted over the trace chain. Should it offer to rear or kick, from a disposition to break away, the old horse should be urged in his walk, and made to pull it along, whilst a smart tip of the whip will take the courage out of it. According as it evinces a disposition to go on quietly in the work, is determined the length of time it should work at the wheel. When obedient at this, it should be yoked to the plough, and there his sympathy for his companion will soon be called forth; so that after a few landings he will work with energy and good-will, and should then be kindly spoken to, encouraged, and even fondled. The probability is, that its desire for the draught may be evinced too keenly, in which case the pace of the old horse should be subdued and the keenness mitigated by shortening the rein by which it is fastened to the rope round the girth of the old horse.

6091. The colt should be broke in to the cart as well as the plough. It is yoked into a single-horse cart, but great care should be used on the first yoking that it gets no fright, by any strap rubbing against it, or the shafts falling upon it when raised up to allow of its being backed below them; for if frightened at the first yoking to a cart, a long time will elapse ere it will submit to any yoking quietly. The horse-breaker should stand in the cart using double reins; and a rein should be held by a man walking first on each side of its head, and then at a little distance on the side of the road. The chief danger is kicking, and thereby injuring the hocks against the front-bar of the cart, to prevent which a rope should be placed across the top of the colt's rump, and fastened to the harness there, and on each side to the shaft of the cart. There is little danger of its running away while all the harness and reins are good. It will take to the traces of the cart more readily at first than with the trams, as they are similar to the harness it had worn at the plough, and it is conscious of having its companion behind it.

6092. A young horse may be broke in for work any time in the course of the spring, from the beginning of working the turnip-land to its completion. I can affirm the efficiency of the plan I have recommended by experience, and it is one which has been unattended with the slightest accident in its practice.

6093. On the first use of harness by a young horse, the shoulders and back are liable to become inflamed, and even the skin to be broken by the collar and saddle. It should first be ascertained whether the collar it is to work in fits it properly; and if not, it should be made to do so before being used, as the first day's use may injure its skin as much to give it pain for weeks thereafter. The usual affections are heated swellings in the line of the collar and seat of the saddle. A good lotion for those parts whenever the colt comes out of yoke is a solution of common salt in warm water, when it becomes cold, and applied as a fomentation with a sponge. The water not only cools the skin, and keeps down the inflammation, but the salt hardens it for use; and in the course of a

short time, particularly if the weather be dry, the skin will become injured to the pressure of the harness.

6094. It is the usual practice to shoe and dock the young horse before putting it to the yoke. I think he should first be broke in, and then he will suffer himself to be shod the more quietly. At the *first shoeing*, it will be useful, in making it stand quietly, and in diverting its attention, to take the old horse it has been working with to the smithy. By nailing a mat against the wall, and making it stand alongside the mat, it will save its skin being ruffled should it rub against the wall, whilst the wall will form a firm barrier against its retreating farther from the blacksmith. After the fore and hind feet of one side have been shod, that side should be turned next to the wall to get its other feet shod. Gentle and coaxing means should be used, though a twitch on the nose has a powerful command over any horse. The first shoes of a young horse should be light, with no heels, and the hoofs should not be pared down much at first. Rather renew the shoes, and pare the hoofs down again in a short time, than encumber a colt at first with heavy shoes and heels, at the risk of trampling himself, to cure the effects of which may cost much more than the price of several sets of new shoes. A severe paring down of the hoof, too, at once, and at first, is apt to superinduce tenderness in the feet, and may even bring out corns.

6095. As to *docking* a draught-horse, I think it a necessary operation, because a long rump is very apt to be injured when the horse is yoked in the trams, by coming against the body of the cart; and in coup-carts especially it can scarcely escape being nipped by the body of the cart, when brought down upon the front-bar. Besides, a draught-horse with a *long* tail soon gets himself much dirtied in winter, both on the land and the road. A neat swish is all that is requisite at any time, and in winter even that is apt to become loaded with mud on dirty roads. Some writers affect to believe it presumptuous in man to deprive any animal of six of the joints of the vertebral column which nature has given it; and no doubt were our horses always idle, especially in sum-

mer, when a long tail is of service, in whisking off flies, the vertebræ ought to be kept entire; but no greater absurdity accompanies the docking off a tail than in the paring of the crust of the hoofs, and driving iron nails into them; and yet, without iron shoes to protect the horny feet of the horse, they would be beaten to pieces upon hard roads, even at a walking pace. No necessary cruelty attends the act of docking, an operation of the simplest form when properly done in a joint where the wound easily heals.

ON BREAKING IN YOUNG SADDLE-HORSES.

6096. As you may breed saddle-horses as well as draught ones, a few words on the breaking in of them after their treatment as young horses in the haummels, (1430) and (1431,) may prove useful.

6097. The age of 3 years seems a good one for breaking in a saddle-horse. The colt should be sent to grass at the end of May, and taken in to break by August at latest, by which time the grass will have operated beneficially upon him as medicine; and there will be sufficient time to teach it its paces, and put it in a working condition before the fall of the year, when horses are apt to become soft, and catch colds. But were it kept longer at grass, its condition might become so fat as to endanger its constitution, were the fatness suddenly reduced in the breaking in to working order.

6098. The first thing, in bringing a horse into the stable, to which it should have been accustomed from his foalhood, is to give a gentle dose of medicine to clear the bowels of grass. A second dose may be repeated in a week. A little new-made hay with oats is the best food as a transition from grass to hard food. The first treatment with the cavesson and bridle are the same as for the draught horse (6088.) Much lunging in a circle is not advisable at any time, and not at all at first for a young riding-horse, though horse-breakers are very fond of giving it this sort of exercise, because it saves themselves much travelling, while the horse may have as much exercise as the breaker chooses

The evil of much lunging is, that the constant motion round the circle is apt to cause a young horse to contract a long step and a short. The circle is most useful in training to *canter*, when a leading foot is requisite in that sort of action. The first tuition should be a straightforward pace, on a leaf-field, and the *only* pace a *walk*, which should be taught to be free with an easy head, as well as a short one with a tight rein. During the period of the walking-tuition, a great many useful lessons should be taught the colt, which circumstances may suggest, such as turning from you and to you—backing, whether quickly or slowly—being led, whether by the side of the head with the hand on the bridle-bit, or in front with a slack rein—standing still, whether for a short or long time—suffering to be tied to any object, such as a gate or tree—passing objects of terror, or of uncertainty, causing the animal to become acquainted with everything it does not seem to recognise—becoming accustomed with the crack of the long, and the slight touch of the short whip—yielding the fore and hind legs when lifted—and suffering the groom to go about it and arrange, however minutely, the breaking-harness. With all these matters the young colt will become much sooner *familiarised*, by the breaker going constantly about with it on foot as a companion on the road and the field, than when mounted on its back; but the usual custom is for the breaker to mount—that is, to place a burden upon the back of a raw, timid, young colt, and to rein it and to irritate it with the spur, which is ever ready, long before the awkward creature knows how to set down one foot before the other in the artificial system in which it is about to be trained. The man, however, must be mounted, which is enough for him, whether or not the colt be fit to be mounted.

6099. In the stable, too, the same system of tuition should be followed out, such as suffering a person to go up on either side, and in any way—suffering to be groomed, and rather liking it than opposing it, as is too often the case—going over to one or other side of the stall, when the bed is being shaken up—drinking out of a

pail in the stable, and at the trough of a pump—taking up with a dog in the stable or on the road—bearing, without a startle, the fall of the pail-handle, the broom, or anything else—lifting the feet at the pail to be washed—bearing the curry-comb on the legs—being led by the forelock to the door, the pump, or any where. These, and many other things, the colt should be taught to know in and out of the stable before he is mounted at all.

6100. Thus familiarised, it will allow itself to be mounted without much trouble; and the assistance of boys with whips, and of men to hold down the opposite stirrup, recommended by Mr. Youatt, dispensed with.* Thomas Middlemiss of Norham in Northumberland, the horse-breaker and groom before alluded to, never required any assistance to mount a young horse, although he was a stout man, nor did any person ever see him mount one for the first time. No fuss should be made about the colt at any time, whether in mounting or anything else; nor a number of persons be collected about it when anything is done, else it will become apprehensive. It will soon confide in one person, the breaker who is constantly about it, but it will not trust a number of persons at the same time; nor will it trust even the breaker, when others are engaged along with him; and hence no considerate horse-breaker will permit any one to be near him, to distract the attention of the colt, while he is subjecting it to tuition of any kind. When mounted, the colt should bear its rider standing still for some time before it is urged to walk, as that will habituate it to stand at all times when mounted until its rider is ready to move. Every one must have felt the annoyance of mounting a horse that will not stand to be mounted, or after being mounted. Its first pace should again be a walk, which having accomplished well with a rider, the trot should be taught. It is said that trotting is not a *natural* pace for a horse, that it either walks or starts off at a *canter*. However this may be, trotting is an indispensable pace on our roads. On teaching trotting, horse-breakers are very apt to degenerate

* Youatt *On the Horse*, p. 321-4.

the pace into a jog, the most dangerous of all paces for a young horse in causing it to trip, and the most difficult to break a horse from, when contracted. A short hitching walk, ready to break into the jog, is as bad as the jog itself, and is a favourite pace with horse-breakers in showing off their pupils as fast walkers; but the pace is not the proper walking one, and in such a pace a young horse is almost sure to dig a toe into the ground, and if a stumble is *not* the consequence, it is not the *man's* fault. Let the walk be a sound walk, and a trot a fair trot, and let no bastard pace be permitted to spoil both. It is not easy to teach a young horse to canter from a trot in a straight line, as it is more apt to start off to the gallop. A few lessons in the circle is the surest way of giving it an idea of a canter, and teaching it to point the leading foot. There is risk at first in making a young horse convert quickly a canter into a trot; the actions being so very different it seems at a loss what to do, and would rather halt. A sudden halt should be avoided at first with a young horse, as it may throw it upon its haunches, and irrecoverably bring it over upon its back; and such an accident as this the colt will never forget, and, in fear of its recurrence, may become restive whenever pulled up suddenly at any time thereafter. Every untoward manœuvre with a young horse—and no one knows what it will do—that may occasion any sort of accident to it, should be carefully avoided by the rider, and counteracted with firmness when originating with the colt.

6101. Thus day by day the young horse will acquire experience in the management of itself on the road, or in the field; but a series of experiences, such as these, is a work of much time to both man and horse—of much patience and perseverance to the man—of much endurance and annoyance to the horse. Above all, much of the benefit derived from even a good horse-breaker will be lost, if the future rider of the horse does not guide it in a similar manner, and with equal care, for some time to come. If considerations such as these do not induce the owners of horses to employ only men of skill and character in breaking them in, I do not know a stronger motive that can be placed before them to do it.

ON TRAINING AND WORKING THE SHEPHERD'S DOG.

6102. The natural temper of the shepherd may be learned from the way in which he works his dog among sheep. When you observe an aged dog making a great noise, bustling about in an impatient manner, running fiercely at a sheep and turning it quickly, biting at its ears and legs, you may conclude, without hesitation, that the shepherd who owns it is a man of hasty temper. Most young dogs exhibit these characteristics naturally, and they generally overdo their work; and if you observe a shepherd allowing a young dog to take its own way, you may conclude that he also is a man who loses his temper with his flock. If you observe another shepherd allowing his dog, whether old or young, to take a range round the fences of a field, driving the sheep within sight as if to gather them, you may be sure he is a lazy fellow, more ready to make his dog bring the sheep to him than he to walk his rounds amongst them. Great harm may accrue to sheep by working dogs in these ways. Whenever sheep hear a dog bark that is accustomed to bound them every day, they will instantly start from their grazing, gather together, and run to the farthest fence, and a good while will elapse ere they will settle again. And even when sheep are gathered, a dog of high travel, that is allowed to run out, will drive them hither and thither, without an apparent object. This is a trick practised by lazy herds every morning when they first see their flock, and every evening before they take up their lair for the night, in order to count them the more easily. When a dog is allowed to run far out, it gets beyond the control of the shepherd; and such a style of working among wether sheep puts them past their feeding for a time: with ewes it is very apt to cause abortion; and with lambs, after they are weaned, it is apt to overheat them, and a considerable time will elapse before they recover their natural breathing. Whenever a sorting takes place among the sheep, with such a dog they will be moved about far more than is necessary; and intimidated sheep, when worn into a corner, are far more liable to break off than those treated in a gentle manner.

6103. A judicious herd works his dog in quite a different manner. He never disturbs his sheep when he takes his rounds amongst them at morning, noon, and night—his dog following at his feet as if he had nothing to do, but ready to fulfil its duty, should any untoward circumstance require its services, such as breaking out of one field into another. When he gathers sheep for the purpose of sorting, or of catching particular ones, the gathering is made at a corner, and to gain which he will give the sheep the least trouble; making the dog wear to the right and left, to direct the sheep to march quietly towards the spot; and after they are gathered, he makes the dog to understand that it is its chief duty to be on the watch, and, with an occasional bark, prevent any of the sheep breaking away. When a sheep does break away, and must be turned, he does not allow the dog to bite it, nor even to bark, but to give a bound at its head, and thus turn it. In attempting to turn a Black-faced wether in this way, the dog runs the risk of receiving injury from its horns; to avoid which I have seen one seize the coarse wool of the buttock, and hang by it like a drag, until the sheep was turned round in the opposite direction, when it is let go. In short, a well-tempered herd only lets his dog work when its services are actually required, he fulfilling his own duties faithfully, and only demanding assistance from his dog when the business cannot be so well done by himself; and at no time will he allow his dog to go beyond the reach of his immediate control. Dogs, when thus gently and cautiously trained, become very sagacious, and will visit every part of a field where sheep are most apt to stray, and where danger is most to be apprehended to befall them—such as a weak part of a fence, deep ditches, or deep furrows into which sheep may possibly fall and lie *awalt* or *awkward* (that is, lie on the broad of their back, unable to get up)—and they will assist to raise them up by seizing the wool at one side and pulling the sheep over upon its feet. Experienced dogs will not meddle with ewes having lambs at foot, nor with tups, being quite aware of their disposition to offer resistance. They also know full well when foxes are on the move, and give evident symptoms of uneasiness on their approach to the lambing ground. They also hear footsteps of

strange persons and animals at a considerable distance at night, and announce their approach by unequivocal signs of displeasure, short of grumbling and barking, as if aware that those noisy signs would betray its own presence. A shepherd's dog is so incorruptible that it cannot be bribed, and will not permit even a known friend to touch it when intrusted with any act of duty.

6104. As far as my observation extends, I think there are two varieties of the shepherd's dog, one smooth, short-haired, generally black-coloured on the back, white on the belly, breast, feet, and tip of the tail, with tan-coloured spots on the face and legs; the other is a larger and longer-bodied animal, having long hair of different colours, and long flowing tail. Fig. 557 is a portrait of one of the latter

Fig. 557.



THE SHEPHERD'S DOG.

class in the act of watching. In their respective characters I conceive them to be very like the pointer and the setter. The small smooth kind, like the pointer, is very sagacious, slow, easily broke and trained; and admirably suited to work in an enclosed and low country; the other, like the setter, is more swift, bold, ill to break, and requiring coercion, and fitter for work on the hills. The former answers the habits of Leicester sheep, the latter those of the Cheviot and Black-faced. The latter, requiring a great range to work in, on account of the nature of the sheep and of the ground which they frequent, are bold and rough in action; still they should be trained to work with caution, and not with recklessness.

6105. Most shepherds profess to be able to train young shepherds' dogs, wherein many display much ignorance of the nature of the breed, and of the aptitude of the particular animal for its peculiar work; and hence many dogs are rendered unfit for service. Every shepherd's pup has a natural instinct for working among sheep, nevertheless they should always be trained with an old dog. Their ardent temperament requires subduing, and there is no more effectual means of doing so than keeping it in company with, and making it imitate the actions of, an experienced quiet dog. A long string attached to the pup's neck, in the hands of the shepherd, will be found necessary to make it acquainted with the language employed to direct the various evolutions of the experienced dog while at work. With this contrivance it may be taught to "hold away out by," to "come in," to "come in behind," to "lie down," to "be quiet," to "bark," to "get over the dyke or fence," to "wear," that is, to stand as a barrier; to "heel," that is, to drive on, to "keep," that is, to intercept. It will learn all these evolutions, and many others, in a short time, in imitation of its older companion and guide. It is supposed that the bitch is more acute than the dog, though the dog will bear the greater fatigue. Of the two, I believe that the quietly disposed shepherd prefers the bitch, and is careful in working her as little as he can when in pup.

6106. The shepherd's dog on a farm claims exemption from taxation; and I believe that a well-trained one costs at least £3.

6107. A volume would not contain what might with truth be said of the sagacity and faithfulness of the shepherd's dog. Suffice it for me to give a few general observations, which I know to be correct. "If he be but with his master," observes the late Mr Youatt, "he lies content, indifferent to any surrounding object, seemingly half asleep and half awake, rarely mingling with his kind, rarely courting, and generally shrinking from the notice of a stranger. But the moment duty calls, his sleepy listless eye becomes brightened, he eagerly gazes on his master, inquires and comprehends all he is to do, and, springing up, gives himself to the discharge of his duty with a sagacity and fidelity and devotion too rarely equalled even by man himself." "If we

consider," says Buffon, "that this animal, notwithstanding his ugliness and melancholy look, is superior in instinct to all others; that he has a decided character, in which education has comparatively little share; that he is the only animal born perfectly trained for the service of others; that, guided by natural powers alone, he applies himself to the care of our flocks—a duty which he executes with singular assiduity, vigilance, and fidelity; that he conducts them with an admirable intelligence, which is a part and portion of himself; that his sagacity astonishes at the same time that it gives repose to his master, while it requires great time and trouble to instruct other dogs for the purposes to which they are destined: if we reflect on these facts, we shall be confirmed in the opinion that the shepherd's dog is the true dog of nature, the stock and model of his species." "The shepherd's dog," remarks Professor Gragnier, "the least removed from the natural type of the dog, lives and maintains its proper characteristics, while other races often degenerate. Everywhere it preserves its proper distinguishing type. It is the servant of man, while other breeds vary with a thousand circumstances. It has one appropriate mission, and that it discharges in the most admirable way; there is evidently a kind and wise design in this." Mr Hogg, the Ettrick Shepherd, truly says that "a single shepherd and his dog will accomplish more, in gathering a flock of sheep from a Highland farm, than seventy shepherds could do without dogs; in fact, that, without this docile animal, the pastoral life would be a blank. It would require more hands to manage a flock of sheep, gather them from the hills, force them into houses and folds, and drive them to markets, than the profits of the whole flock would be capable of maintaining. Well may the shepherd feel an interest in his dog: he it is indeed that earns the family bread, of which he is himself, with the smallest morsel, always grateful and always ready to exert his utmost abilities in his master's interests. Neither hunger, fatigue, nor the worst of treatment will drive him from his side, and he will follow him through every hardship without murmur or repining."*

ON SLAUGHTERING OXEN, SHEEP, AND PIGS.

6108. That man cannot be accounted a proficient shepherd, if he cannot slaughter oxen, sheep, pigs, and calves, as well as a professed butcher. This qualification is necessary, not only on account of slaughtering the animals used at the farmer's table, but in case of casualties overtaking the stock, which, if not slaughtered instantly, and dressed, would become a source of much loss to the farmer were they to die in their blood; and it would never

* Youatt *On the Dog*, p. 59-64.

answer to have to send to a town for the assistance of a butcher. For his convenience, a slaughter-house ought to be fitted up, of which he is the acknowledged custodian, and which it is his duty to keep clean and wholesome; but its key should be kept in the farm-house.

6109. It is necessary for you to know the methods in which the different animals are slaughtered, that you may judge whether or not the shepherd does justice to this part of his duty; and you should also be acquainted with the appearance of good meat, and of the method of managing it, in order to be able to bargain well with the butcher when you may have slaughtered carcasses to dispose of to him.

6110. The slaughter-house should not be in the steading, both on account of the inconvenience of bringing an animal into it, and of the impossibility of keeping the house so free of effluvia as not to be recognised as the place of slaughter. In fitting it up, the floor should be laid with clean-droved pavement, and have a decided slope to the side at which the drain is made to take away the dirty water occasioned by cleansing. The walls should also be plastered, and a ventilator, fig. 81, placed on the roof, to maintain a draught of air. The site chosen should be in a cool shady place, and at the same time easily accessible to animals, and even to a cart, should it bring a dead one to be dressed. A locked closet is useful to hold the knives, steel, and stretchers, and the outer-door should be provided with a good thumb-latch, lock, and key. A block and tackle should be suspended from a beam extending across the apartment from wall to wall, to hoist up the heavy carcasses by. Water should be close at hand to wash out the house clean every time it is used.

6111. *Oxen*.—Oxen are made to fast before being slaughtered. The time they should stand depends on the state of the animal on its arrival at the shambles. If it has been driven a considerable distance in a proper manner, the bowels will be in a tolerably empty state, so that 12 hours may suffice; but if full, and just off its food, 24 hours will be required. Those that have been overdriven, or much struck

with sticks, or are in any degree infuriated—or *raised*, as it is termed—should not be immediately slaughtered, but allowed to stand on dry food, such as hay, until the symptoms have entirely disappeared. The reason for the fasting before slaughtering is to give time for the paunch and intestines to empty themselves entirely of food, as it has been found, when an animal is killed with a full stomach, the meat is more liable to putrefy, and is not so well flavoured; and as ruminants always retain a large quantity of food in their intestines, it is reasonable they should fast somewhat longer to get quit of it than animals with single stomachs.

6112. Cattle are slaughtered in a different mode in different countries. In the great *abattoirs* at Montmartre, at Paris, they are killed by breaking the spinal chord of the cervical vertebræ, which is accomplished by driving a sharp-pointed chisel between the second and third vertebræ with a smart stroke of a mallet, while the animal is standing, when it drops down on the floor, and death or insensibility immediately ensues, and the blood is let out by opening the blood-vessels of the neck. This is also the mode of slaughtering in Germany. In this country the plan is first to bring the ox down on his knees, and place his under jaw upon the floor by means of ropes fastened to his head, and passed through an iron ring in the floor. He is then stunned by blows from the sharp-pointed back of an iron axe, made for the purpose, on the forehead, the bone of which is usually driven into the brain. The animal falls on one side, and the blood is let out by the neck. Of the two modes, the French is apparently less cruel, for some oxen require many blows to make them fall: I once witnessed an ox receive nine blows before it fell. I have heard it alleged by butchers of this country, that the separation of the spinal chord, producing a general nervous convulsion throughout the body, prevents the blood flowing so rapidly and entirely out of it as when the ox is stunned by a blow on the forehead. The skin is then taken off to the knees, where the legs are disjoined, and also off the head: The carcass is then hung up by the tendons of the hough, on a stretcher, by the block and tackle

worked most easily with a small winch, which keeps good what rope it winds up by a wheel and ratchet. The loose tallow is rolled up by itself. The heart, head, and feet are sold separately to families and hotel keepers. The paunch is cleaned and sold to the tripe-cooks. The lights—that is, the lungs and liver—are used for dogs-meat.

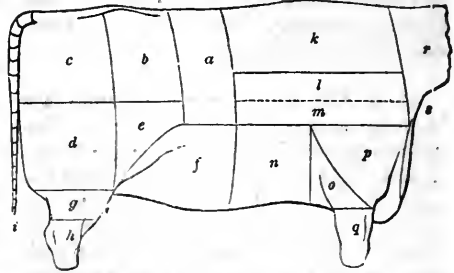
6113. After the carcass has hung 24 hours, it should be cut down by the backbone, or chine, into two *sides*. This is done either with the saw or chopper—the saw making the neatest job in the hands of an inexperienced butcher, though the most laborious; and it is the quickest with the chopper, but by no means the neatest plan, especially in the hands of a careless fellow. In London the chine is equally divided between both sides, while in Scotland one side of a carcass of beef has a great deal more bone than the other, all the spinous processes of the vertebra being left on it. The bony is called the *lying* side of meat. In London the divided processes in the fore quarter are broken in the middle when warm, and chopped back with the flat side of the chopper, which has the effect of thickening the fore and middle ribs considerably when cut up. The London butcher also cuts the joint above the hind knee, and, by making some incisions with a sharp knife, cuts the tendons there, and drops the flesh of the hind quarter on the flanks and loins, causing them to cut up thicker than in the Scotch mode. In opening up the hind quarter, he also cuts the aitch-bone or pelvis through the centre, which makes the rump look better. Some butchers in the north country score the fat of the *closing* of the hind quarter, which has the effect of making that part of both the heifer and the ox look like the udder of an old cow. Scoring is too much practised in Scotland, and ought to be abandoned.

6114. The *carcass* consists of the entire useable meat of the body, which, when sawn down the middle of the back-bone, is divided into two *sides*, which, when again divided by the 5th rib, make them consist of 4 *quarters*. The remainder of the animal consists of *offal*—namely, of fat, entrails, head, and skin. In purchasing fat livestock, the butcher is supposed to pay the

market value of the carcass, bone and meat, to the farmer, reserving the offal to himself for his profit and risk.

6115. A figure of the Scotch and English modes of cutting up a carcass of beef will at once show you their difference; and on being informed where the valuable pieces lie, you will be enabled to judge whether the oxen you are breeding or feeding possess the properties that will enable you to demand the highest price for them. The Scotch mode of cutting up a carcass of beef is represented in fig. 558,

Fig. 558.



THE SCOTCH MODE OF CUTTING UP A CARCASS OF BEEF.

and the different pieces of meat receive these names:—

In the hind quarter.		In the fore quarter.	
a, The sirloin, or back sey.	k, The spare rib, or fore sey.	l, .. runner, } large & small,	
b, .. hook-bone.	m, .. runner, } large & small,	n, .. nineholes.	
c, .. buttock, } the rump	o, .. brisket.	p, .. shoulder-lyar.	
d, .. largeround, }	q, .. nap or shin.	r, .. neck.	
e, .. thick flank.	s, .. sticking piece.		
f, .. thin flank.			
g, .. small round.			
h, .. hough.			
i, .. tail.			

a the sirloin is the principal roasting piece, making a very handsome dish, and is a universal favourite. It consists of two portions, the Scotch and English sides; the former is the one above the lumbar bones, and is somewhat hard in ill-fed oxen; the latter consists of the muscles under those bones, and are generally covered with fine fat, which are exceedingly tender; the better the beast is fed, the larger is the under muscle, better covered with fat, and more tender to eat: b the hook-bone, and c the buttock, are cut up for steaks, beef-steak pie, or minced collops—and both these, along with the sirloin, fetch the highest price: d is the large round, and e the small round, both well known as excellent pieces for salting and boiling, and are eaten cold with great

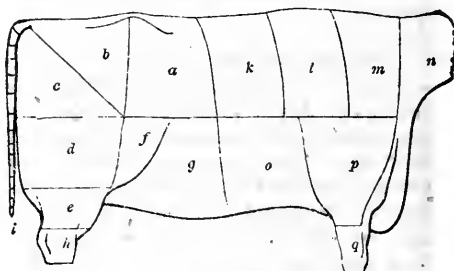
relish : *k*, the hough, is peculiarly suited for boiling down for soup, having a large proportion of gelatine. Brown soup is the principal dish made of the hough, but its decoction forms an excellent *stock* for various dishes, and will keep in a state of jelly for a considerable time. The synovial fat, skimmed off in boiling this piece, and poured upon oatmeal, seasoned with pepper and salt, constitutes the famous *fat brose* for which Scotland has long been celebrated; and it was of this piece that the old favourite soup of Scotland, named *skink*, was made: *e* the thick and *f* the thin flank, both excellent pieces for salting and boiling: *i* is the tail, and insignificant as it may seem, it makes soup of the finest flavour; but hotel-keepers have a trick of seasoning brown soup, or rather beef-tea, with a few joints of the tail, and serving it up for genuine ox-tail soup. These pieces of the hind quarter are valuable for roasting and boiling, not containing a single coarse piece.

6116. In the fore quarter is *k*, the spare rib or fore sey, the six ribs of the back end of which make an excellent roast, and when taken from the side opposite to the *lying* one, being free of the bones of the spine, makes a large one; and it also makes excellent steaks and beef-steak pie: *l* and *m* the two runners, with *n* the nine-holes, make good salting and boiling pieces; and of these the nine-holes is much the best, as it consists of layers of fat and lean without any bone, whereas the fore-parts of the runners have a piece of the shoulder-blade in them, and every piece connected with that bone is more or less coarse-grained: *o* the brisket between the fore-legs eats very well boiled fresh in broth, and may also be corned: *p* the shoulder-lyar is a coarse piece, and fit only for boiling fresh to make into broth or beef-tea: *q* the nap or shin is analogous to the hough of the hind-leg, but not so rich and fine, there being much less gelatine in it: *r* the neck makes good broth; and the sticking-piece *s* is a great favourite with some epicures, on account of the pieces of rich fat in it, which makes an excellent stew. These consist chiefly of boiling-pieces, the roasting-piece being confined to the six ribs of the spare-rib *k*.

6117. In some of the largest towns in Scotland, a difference of 1d. per lb. is made between the roasting and boiling pieces; but in most towns, and the country villages, all the pieces realise the same prices, and even the houghs and shins fetch 3d. per lb.

6118. In the English mode, the pieces are cut up somewhat differently, especially in the fore-quarter. Fig. 559 shows this

Fig. 559.



THE ENGLISH MODE OF CUTTING UP A CARCASS OF BEEF.

mode, and it consists of the following pieces:—

In the hind-quarter.	In the fore-quarter.
<i>a</i> , The loin.	<i>k</i> , The fore-rib.
<i>b</i> , .. rump.	<i>l</i> , .. middle rib.
<i>c</i> , .. aitch-bone.	<i>m</i> , .. chuck rib.
<i>d</i> , .. buttock.	<i>n</i> , .. clod, and sticking, and neck.
<i>e</i> , .. hock.	<i>o</i> , .. brisket.
<i>f</i> , .. thick flank.	<i>p</i> , .. leg-of-mutton piece.
<i>g</i> , .. thin flank.	<i>q</i> , .. shin.
<i>h</i> , .. shin.	
<i>i</i> , .. tail.	

a the loin is the principal roasting-piece; *b*, the rump, is the favourite steak-piece; *c*, the aitch-bone, the favourite stew; *d* the buttock, *f* the thick flank, and *g* the thin flank, are all excellent boiling-pieces when corned; *e* the hock, and *h* the shin, make soup, and afford *stock* for various purposes in the culinary art; and *i* is the tail for ox-tail soup—a favourite English luncheon. In the curious case of assessing damages against the Bank of England for removing the famous Cock eating-house in Threadneedle Street, it was produced in evidence, that, in the 3 years 1837–8–9, there had been 13,359 ox-tails used for soup; and as 36 tails make 10 gallons of soup, there had been served up 59,360 basins, at 11d. the basin, making the large amount of £2720, 13s. 4d. for this article alone.* These pieces are valuable of their respective kinds.

* *John Bull*, 16th January 1841.

6119. In the fore-quarter, *k* the fore-rib, *l* middle rib, and *m* cluck-rib, are all roasting-pieces, not alike good; but in removing the part of the shoulder-blade in the middle rib, the spare ribs below make a good broil or roast: *n* the neck makes soup, being used fresh; the back end of the brisket *o* is boiled, corned, or stewed; *p*, the leg-of-mutton piece, is coarse, but is as frequently stewed as boiled; *q* the shin is put to the same uses as the shin and the hock of the hind-quarter.

6120. On comparing the two modes of cutting up, the English affords more roasting-pieces than the Scotch, a large proportion of the fore-quarter being used in that way. The plan, too, of cutting the line between *b* and *c*, the rump and aitch-bone in the hind-quarter, diagonally, lays open the steak-pieces to better advantage than does the Scotch buttock *c*, fig. 558.

6121. Extending the comparison from one part of the carcass to the other, in both methods, it will be seen that the most valuable pieces (the roasting) occupy its upper, and the less valuable (the boiling) its lower part. Every ox, therefore, that lays on beef more upon the upper parts of its body, is more valuable than one that lays the same quantity of flesh on its lower parts.

6122. The relative values of the pieces differ much more in London than in Scotland. The rump, loin, and fore-ribs fetch the highest price; then come the thick flank, buttock, and middle-rib; then the aitch-bone, thin flank, chuck-rib, brisket, and leg-of-mutton piece; then the clod, sticking, and neck; and, last of all, the legs and shins. In actual pecuniary value, the last may bear a proportion of only one-fourth to the highest priced.

6123. Of the qualities of beef obtained from different breeds of cattle, I believe the best meat is obtained from the West Highland breed for fineness of grain, and cutting up into convenient pieces for family use. After it has been fed in Norfolk for twelve months, it cannot be excelled even in London. The Galloways and Angns, when fattened on the English pastures, are also great favourites in the London mar-

ket. The Short-horns afford excellent steaks, being thick of flesh, and the slice deep, large, and juicy, and their corned flanks and nineholes are always thick, juicy, and well mixed. The Herefords are somewhat similar to the Short-horns, and perhaps rather finer; and the Devons may be classed amongst the Galloways and Angns, whilst the Welsh cannot be compared to the West Highland. So that, taking the breeds of Scotland as suppliers of good beef, they seem to be more valuable for the table than those of England. Any beef that I have seen of Irish beasts is inferior, but the cattle derived from Britain; fed on the pastures of Ireland, afford excellent meat. Shetland beef is the finest grained of all, but the pieces are very small.

6124. *Sheep*.—Sheep are also made to fast before being slaughtered, and the period is seldom less than 24 hours, unless under extraordinary circumstances. Sheep are easily slaughtered, and the operation is not attended with the same apparent cruelty as with cattle. In the first 24 hours after fasting, sheep lose $8\frac{1}{2}$ lbs. out of 1184 of their weight. They are placed on their side on a stool, called a *killing stool*—the bathing-stool, fig. 427, answers the purpose very well—to be slaughtered, and, requiring no fastening with cords, are deprived of life by a thrust of a straight knife through the neck, between the cervical vertebrae and the windpipe, severing the carotid artery and jugular vein of both sides, from which the blood flows freely out, and the animal soon dies. The skin, as far as it is covered with wool, is taken off, leaving that on the legs and head, which are covered with hair, the legs being disjointed by the knee. The entrails are removed by an incision along the belly, after the carcass has been hung up on a hangrel by the tendons of the houghs. The net fat is carefully separated from the viscera, and rolled up by itself; but the kidney fat is not then extracted. The intestines are placed on the inner side of the skin until divided into the *pluck*, containing the heart, lungs, and liver; the *bag*, containing the stomach; and the *puddings*, consisting of the viscera or guts. The bag and guts are usually thrown away—that is, buried in the dung-hill—unless when the bag is retained and cleaned for a haggis. The skin is hung

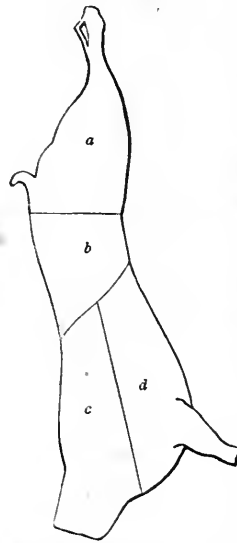
over a rope or pole under cover, with the skin-side uppermost, to dry in an airy place.

6125. Butchers have various ways of displaying a carcass of mutton. Some fold back the flaps of the flanks, and secure them with wooden skewers, and fully expose the interior of the carcass to view; others merely distend them with a long stretcher of wood; whilst some, folding them back, distend them with the stretcher placed across the back. Some distend the breast with a stretcher; others pin the tail down to the rump with a skewer; whilst many cut a cross with the knife upon the skin of the shoulder, which, contracting, shows the fat underneath; and, to make the whiteness of the fat appear more conspicuous, the skin is first reddened with a lock of wool dipped in blood. Figures are even carved on the neck and other parts of the carcass. All these expedients are useless in themselves, and injurious to the meat, inasmuch as they distort the shape of the pieces when cut out, and should therefore be abandoned, and the carcass allowed to hang intact after the entrails have been removed—with the exception, perhaps, of distending the flaps of the flank a little with a short stretcher, to allow the air to dry the inside of the carcass. The membranous covering of the outside of the carcass has different colours, that of the shoulder and flanks being red, and white along the back. The redness is brighter coloured in Black-faced sheep than in any other breed I have observed, and gives the meat a tempting appearance.

6126. The carcass should hang 24 hours in a clean, cool, airy, dry apartment, before it is cut down—*cool*, for if warm the meat will never become firm; and *dry*, for if damp a clamminess will cover it, which will never become dry, nor have a fresh clean appearance. The carcass is divided in two by being sawn right down the back-bone. The kidney fat is then taken out, being only attached to the peritoneum by the cellular membrane, and the kidney is extracted from the *suet*—the name given to sheep tallow in an independent state. The fat of a sheep weighs about one-sixth of the weight of the carcass. When the sides are divided by the 5th rib, they constitute the four quarters.

6127. In almost every town there is a different way of cutting up a carcass of mutton; and it being here impossible to advert to them all, I shall select those of Edinburgh and London, and distinguish them as the Scotch and English modes. Although the English mode is upon the whole preferable, having evidently been adopted to suit the tastes of a people long acquainted with domestic economy, yet meat is cut up in Scotland in a cleanly and workman-like style; but it cannot be denied that the beauty and cleanliness of meat, as exhibited in London, call forth the admiration of every connoisseur. The Scotch mode is represented in fig. 560,

Fig. 560.



where, in the hind-quarter, *a* is the *jigot* and *b* the *loin*, and, in the fore-quarter, *c* the *back-ribs*, and *d* the *breast*. The *jigot* is cut with a part of the haunch or rump, and the fore-quarter right through the shoulder into two pieces. The *jigot*, *a*, is the handsomest and most valuable part of the carcass, and on that account fetches the highest price.

THE SCOTCH MODE OF CUTTING UP A CARCASS OF MUTTON. It is either a roasting or a boiling piece. Of Black-faced mutton it makes a fine roast, and the piece of fat in it called the *Pope's-eye* is considered a delicious *morceau* by epicures. A *jigot* of Leicester, Cheviot, or Southdown mutton makes a beautiful "boiled leg of mutton," which is prized the fatter it is, as this part of the carcass is never overloaded with fat. The *loin* *b* is almost always roasted, and is a juicy piece, the flap of the flank being skewered up. Many consider this piece of Leicester mutton roasted too rich, and when warm it is probably the case; but a cold roast *loin* is an excellent summer dish. For a small family, the Black-faced

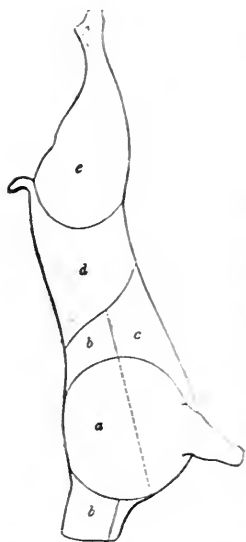
mutton is preferable; for a large, the Southdown and Cheviot. The back-ribs *c* are divided in two, and used for very different purposes. The fore-part, the neck, is boiled, and makes the sweetest barley-broth of any part of the mutton; and the meat, when well boiled, eats tenderly. The back-ribs make an excellent roast, there not being a sweeter or more varied one in the carcass, having both ribs and shoulder. The shoulder-blade eats best cold, and the ribs warm. The ribs also make excellent chops. The Leicester and Southdowns afford the best mutton-chops. The breast *d* is mostly a roasting piece, consisting of rib and shoulder, and is particularly good when cold. When the piece is large, as of Southdown or Cheviot, the gristly part of the ribs may be divided from the true ribs, and helped separately. The breast is an excellent piece in Black-faced mutton, and suitable to small families, the shoulder being eaten cold, while the ribs and brisket are sweet and juicy when warm. This piece also boils well; or, when corned for 8 days, and served with onion sauce, with mashed turnip in it, few dishes are more savoury at the farmer's table.

6129. The shoulder *a*, separated before being dressed, makes an excellent roast for family use, and may be eaten warm or cold, or corned and dressed as the breast mentioned above. The shoulder is best from a large carcass of Southdown or Cheviot, or Leicester, the Black-faced being too thin for the purpose; and it was probably because English mutton is usually large that the practice of removing it originated. The neck-piece *b b* is partly laid bare by the removal of the shoulder, the fore-part being fitted for boiling and making into broth, and the best end for roasting or broiling into chops. On this account this is a good family piece, and in such request among the tradesmen of London that they prefer it to any part of the hind-quarter. Heavy mutton, such as the Leicester, Southdown, and Cheviot, supply the most thrifty neck-piece. The breast *c* is much the same sort of piece as in the Scotch method, but the ribs are here left exposed at the part from which the shoulder had been removed, and constitute what are called the *spare ribs*, which may be roasted, or broiled, or corned. The back end of the breast makes a good roast for ordinary use. The flap of the loin left attached to this piece may be used in making broth. The loin *d* is a favourite roast in a family; and when cut double, forming the chine or saddle, it may grace the head of the table of any public dinner. Any of the kinds of mutton is large enough for a saddle; but the thicker the meat, of course the larger the slice. The leg *e* is cut short and roasted. When cut long, taking in the hook-bone, it is similar to a haunch of venison, and roasted accordingly. A fat Black-faced wether, such as are bred and fed by Lord Panmure, at Panmure, Forfarshire, yields a splendid haunch.

6130. The different sorts of mutton in common use differ as well in quality as in quantity. The flesh of the Leicester is large, though not coarse-grained, of a lively red colour, and the cellular tissue between the fibres contains a considerable quantity of fat. When cooked it is tender and juicy, yielding a red gravy, and having a sweet rich taste; but the fat is rather too much and too rich for some people's tastes, and may be put aside; while it must be allowed that the lean of fat meat

6128. The English mode of cutting up

Fig. 561.



THE ENGLISH MODE OF CUTTING UP A CARCASS OF MUTTON.

a carcass of mutton is represented in fig. 561, where in the fore-quarter *a* is the shoulder; *b b* the neck; *c* the breast extending beneath the shoulder; and in the hind-quarter *d* is the loin, and *e* the leg. The leg is cut short like a ham, without any of the haunch; and the shoulder, comprehending the scapular region, is removed entire.

is much better in flavour and quality than lean meat without fat. Leicester sheep generally attain to heavy weights, hogs reaching 18 lb. or 20 lb., and dimmotts 30 lb. per quarter; but 5 dimmotts which I remember seeing, belonging to the late Mr Edward South, Marldown, Northumberland, weighed 55 lb. a quarter overhead, when killed at Newcastle in November, a few weeks after they were exhibited at the show at Coldstream of the Border Union Society. These were the sheep I referred to which the four shepherds were unable to turn in, (3584.)

6131. Cheviot mutton is smaller in the grain, not so bright of colour, with less fat, less juice, not so tender and sweet, but the flavour is higher and the fat not so luscious. The weight attained by a hogg may be taken at 14 lb. or 15 lb., and by a wether at 22 lb.; but Mr Fairbairn mentions having fattened 5 wethers in 1818 which averaged 30 lb. a quarter.* Much of the prejudice existing in London against Scotch mutton arises from the hasty manner in which the carcasses are packed, and the consequent bruises observed on the meat.

6132. Black-faced mutton is still smaller in the grain, of a darker colour, with still less fat, but more tender than the Cheviot, and having the highest flavour of all. The ordinary weight of a fat wether is about 18 lb. or 20 lb. a quarter; but I remember seeing a lot of 5-year-old Black-faced wethers, at a Show of the Highland and Agricultural Society at Perth, belonging to Lord Panmure, that averaged 40 lb. a quarter. The 4-year-old wethers at Panmure commonly weigh 30 lb. per quarter.

6133. The mutton of Southdowns is of medium fineness in grain, colour pleasant red, fat well mixed with the meat, juicy, tender than the Cheviot, and of pleasant though not of so high a flavour as the Black-faced. The ordinary weight may be from 16 lb. to 22 lb. a quarter; but 3 wethers exhibited by Mr Grantham at the Show of the Smithfield Club in 1835, weighed, on the average, 41½ lb. a quarter.† Southdown mutton is fast gaining ground

in Scotland, the joints being of nice size for family use, and well shaped.

6134. Welsh is the smallest and the very highest flavoured of all mutton raised in Britain; but the moment the sheep are fed in the low country, much of the wild flavour, which is its chief recommendation, is lost.

6135. Tup-mutton of any breed is always hard, of disagreeable flavour, and in autumn not eatable. The mutton of old ewes is dry, hard, and tasteless, but of young well enough flavoured, but still rather dry. Hogg-mutton is sweet, juicy, and tender, but flavourless. Wether-mutton is the meat in perfection, according to its kind.

6136. The average quantity of fat afforded by each sheep of every class, sold in any given market in Scotland, is perhaps not great. In Glasgow, for example, where heavy animals of all sorts are generally sold, the fat afforded by all the sheep—consisting chiefly, I presume, of Cheviot and Black-faced—exclusive of lambs, amounting to 57,520 head, sold in 1822, was only, on the average, 4 lb. 13 oz. per head.‡ From 8 lb. to 12 lb. is the ordinary quantity obtained from Leicester sheep slaughtered on farms of good land; and in Edinburgh, I find that 7 lb. is considered an average from Black-faced and Cheviot sheep, which shows that the quality of mutton sold there is better than that in Glasgow. The quantity, I have no doubt, is on the increase.

6137. Pigs.—Pigs, when about to be killed, should be made to fast for nearly a day, to clear their bowels. The season best adapted to the purpose is in the cool months of the year; the flesh in the warm months not becoming sufficiently firm, and is then liable to be fly-blown before it is cured. For fresh pork, the season of killing does not signify. When you wish to make hams for your own use, Christmas is a good time for slaughtering pigs; and, in doing it, great care should be taken that the animals receive no injury by bruises before being killed, as the flesh, where bruised, will become blood-burned, marked with bruises, and will not take with the

* Fairbairn's *Lammermuir Farmer*, p. 123.

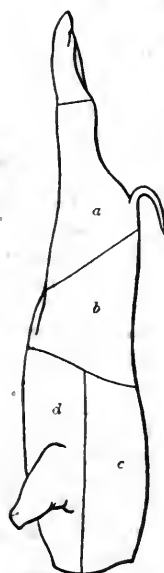
† Youatt *On Sheep*, p. 236.

‡ Cleland's *Account of the Highland and Agricultural Society's Show at Glasgow in 1828*, p. 40.

salt. Butchers are often reckless in slaughtering pigs for this purpose; some stunning them with blows on the head before using the knife, which should never be allowed, as the blows render the head almost useless for curing; others, plunging the knife into the breast, and allowing the pigs to run about until they fall down exhausted by loss of blood, which is a barbarous practice. Butchers are apt to adopt practices which serve their own purposes, when killing animals, and which may not affect the appearance of meat for the short time they have it in their possession; but such hasty and thoughtless practices will not do with animals that are intended to be cured and kept for a considerable time, for the use of a family. I knew of a pig that was to be slain for ham being taken by the hind-leg by the butcher, who, in his recklessness, drove its nose against a wall, and the pig was killed on the spot; and, although bled immediately, the flesh never became firm, or assumed its proper colour. When the time for slaughtering arrives, the animals should be taken out of their sties gently one by one, and placed on their back upon a considerable quantity of straw, and held in that position by assistants, while a long sharp-pointed knife is introduced with a firm hand through the counter near the bottom of the neck, in the opening between the ribs at the sternum into the heart, care being taken that the point of the knife does not miss the opening, and go between the shoulder-blade and the ribs. This error is frequently committed in slaughtering pigs; it is called *shouldering*, and has the effect of collecting a mass of blood under the shoulder-blade, where it coagulates, and prevents the whole shoulder from being cured. Before the slaughtering commences, a large quantity of boiling water should be provided, with which to scald off the hair. This is effected either by putting the carcass into a large tub of water, or, should there not be a tub of sufficient size, the hot water can be poured on the carcass on the straw, and the hair scraped clean from every part of the body with a knife. The hoofs are taken off at this time. Another plan is to singe the bristles off by fire in a state of flame; and this practice is much in use in some parts of England, but not at all in Scotland. I see no advantage in

singeing which scalding cannot afford; it renders the skin dirty by the smoke necessarily arising from the flame and combustion of the bristles. The net fat and entrails are separated, and the carcass is dressed in the most simple manner, with only a single stretcher to keep apart the flaps of the belly. The entrails are washed, and preserved for sausages and puddings.

6138. The carcass hangs in the slaughter-house until next day, when it is sawn up the back-bone into two sides. If it is intended for pickled pork, the sides are cut up in Scotland in the same way as the Scotch mode of cutting up mutton, fig. 560, and is represented in fig. 562,



THE SCOTCH MODE OF CUTTING UP A CARCASS OF PORK.

where *a* is the leg, and *b* the loin, in the hind-quarter; *c* the ribs, and *d* the breast, in the fore-quarter. The leg *a* makes excellent pickled pork, and the loin *b* a juicy fresh roast. The back-ribs of *c* make a fine roasting-piece, and also pork chops, a most delicate dish. The fore-end of *c*, and the whole of the breast *d*, are fit for pickling. The head, split in two, is also pickled, and considered a delicacy, as the fat upon the cheeks is gristly.

6139. The English mode of cutting up pork is different from what has just been described, and, upon the whole, perhaps better adapted for family use. Fig. 563 gives a representation of it, where, in the fore-quarter, *a* is the spare-rib, so called because the flesh and fat are taken off the ribs for salting; and the ribs are then roasted, and make a savoury dish; *b*, the hand or shoulder, fit for pickling; *c*, the belly or spring, also fit for pickling, or for rolling up, when well seasoned with stuffing, for brawn. In the hind-quarter are *d* the fore and *e* the hind

loin, both best when roasted, the fore one *d* also making excellent chops; and

Fig. 563.



f is the leg, which is cut short for pickling. The *neck* is called a *crop* of pork, and, when divided into its vertebræ, is cut for chops, and called *gris-kins*. The head, when divided in two, is again divided at the jaw into an upper part called the *face* or *cheek*, and the lower part named the *chap*. Sometimes the two chaps are not separated. Pork for roasting is best when about six months old; and a leg of pork ought not to exceed 7 lb., nor less than 6 lb., in weight.

through the skin and flesh the whole length of the blade, and if the resistance to it be firm and uniform, the flesh is good; and if irregular and loose and pulpy, the pork has not been well fed. The smell retained by the knife will show whether the flesh be wholesome or tainted.

6141. *Calves*.—Calves are slaughtered by inserting a sharp-pointed knife through the neck, severing the blood-vessels, as in the case of sheep, or the throat is simply cut through to the cervical vertebræ. The skin is taken off to the knees, which are disjoined, and to the head, which is taken off. The carcass is dressed simply, and kept open with a stretcher, though many butchers in Scotland are fond of showing their skill, as they imagine, in dressing a calf, by leaving the lungs, heart, and liver attached, half-splitting down the back-bone, spreading the carcass flat with stretchers across the back, spreading the net fat in front over the offal, and leaving the skin adhering to the back and sides. The enumeration of these particulars shows the absurdity of dressing up a carcass in this manner. The hair is scalded off the head with hot water, and dressed into mock-turtle soup, or a dish, calf's head. The feet are also scalded of the hair with hot water, and made into jelly. The sweetbread or pancreas makes a delicate dish when stewed. It is very seldom that a calf is slaughtered on a farm.

THE ENGLISH MODE OF CUTTING UP A CARCASS OF PORK.

6140. Of judging of pork, "the meat of pigs cut or spayed when young is the best. That of a boar, though young, or of one of full growth, the flesh will be hard, tough, reddish, and of a rank smell; the fat skinny and hard; the skin very thick and tough, and, being pinched up, it will immediately fall again. If it be young, in pinching the lean between the fingers, it will break; and, if you nip the skin with your nails, it will be dented. But if the fat be soft and pulpy, like lard, if the lean be tough, and the fat flabby and spongy, and the skin be so hard that you cannot nip it with your nails, it is old. If there are little kernels in the fat, like hail-shot, the pork is measly and unwholesome, and butchers are punishable for selling it. The freshness of pork may be known by putting the finger under the bone, and smelling it. The flesh of stale pork, also, is sweaty and clammy; that of fresh killed, cool and smooth. Pork fed at distilleries is not good for curing, the fat being spongy. Dairy-fed pork is the best."* A good way of ascertaining the quality of a carcass of pork, is to insert a penknife

6142. The carcass, after hanging 24 hours, is divided into either of two modes, the Scotch and the English. The Scotch mode of cutting up gives in the fore quarter the back-ribs, which, being divided into two joints, give the fore part for boiling, and the hind part for roasting; the breast, which is also divided into the fore part, which is made into soup, and the hind, which is roasted; and the shank, which is made into soup. The hind quarter affords the knuckle, which is made into soup, the fillet, which is roasted, and the loin, which is also roasted.

6143. The English mode of cutting up gives, in the fore quarter, the shoulder, which is roasted, the neck, which is made into soup, and the breast, which is roasted.

* *The Experienced Butcher*, p. 155.

In the hind quarter are the knuckle, which is made into soup, the fillet, which is roasted, and the loin, which is divided into the chump-end and the loin, which are both roasted. The English mode is the better of the two, inasmuch as the pieces are each more equal in the flesh, and handsomer in shape for the table. The English fillet is so cut as to avoid the bone of the rump, which is thrown into the chump-end of the loin.

6144. The best veal in Scotland is reared in the clay farms of Strathaven in Lanarkshire, (2293.) The cruel mode of strapping on the live calves upon the tops of the carrier-carts, on their long journey from Strathaven to Edinburgh, it is hoped, is now discontinued, in consequence of the convenience of carriage afforded by railways. The best veal, in the spring, is to be found in the west of England, but the constant supply to London is from the counties of Surrey and Essex, (2294.) But the veal of England will not compare with that of Pontoise, a village within 6 miles of Paris, for flavour, succulence, and whiteness, (2295.)

6145. *Lambs*.—Lambs are slaughtered in the same manner as sheep, by inserting the knife through the throat. The skin is taken off to the knees, which are disjointed, and it is taken off the head. The carcass is too often made a display of in the dressing, in the manner described in the calf. The head and pluck go together, and make two nice dishes—one, lamb's head, and the other in the liver and lungs fried. But when the bag is retained and cleaned, it is made the receptacle of one of the finest dishes that Scotland can boast of—a lamb's haggis.

6146. Lamb is cut up into quarters, which are larger or smaller according to its age. From 5 lb. to 8 lb. is the usual weight of a quarter of lamb, and when it exceeds the latter weight the meat becomes coarse. Lamb is a frequent dish at the farmer's table, and it is in the highest perfection when the ewe is fed on grass, any artificial food diminishing its quality very rapidly. House lamb is reared in England all the year round. In flavour it will not com-

pare with the grass-fed, but its appearance, at seasons when the meat cannot be obtained direct from the fields, enhances its value, which, in its turn, induces the farmer to rear it. The most thrifty lamb for the farmer is from a cross between the Black-faced ewe and Leicester tup.

6147. *Beef*.—The proportion of tallow to beef generally obtained from cattle sold in the Glasgow market, as stated by the late Dr Cleland, is as 1 to 8, 14,566 head being sold in 1822, averaging exactly 44 stones, of 14 lb. to the stone, of beef, and yielding 5½ stones of tallow. The experiments recorded in (1325) gave the proportion between 1 to 7, and 1 to 8; that in (1332) rather more than 1 to 7. A short-horn cow which slipped her second calf, and was sold after she had been fed for six months after having gone dry, I sold to the late Mr Robert Small, flesher in Dundee, and the tallow obtained from her was 27 stones to 72¼ stones of beef, or as 1 to 2½; while the very large ox exhibited by the late Lord Kintore at the Highland and Agricultural Society's show at Aberdeen in 1834, only yielded 16½ stones of tallow to 173 stones 4 lb. of beef, being exactly 1 to 10½. The offals realise more money, in proportion to their quality, than the flesh, (3623.)

6148. Sufficient data, perhaps, do not exist for determining the true proportion of offals of all kinds to the beef of any given fat ox; but approximations have been made which may serve the purpose until the matter is investigated by direct experiment, under various circumstances. The dead weight bears to the live weight a ratio varying between .55 and .605 to 1, (3624.) and on applying one or other of these multiples to the live weight, according to the higher and lower condition of the animal, you will find a pretty correct approximation. The weight of the tallow, as shown above, is between one-seventh and one-eighth of that of the beef. It follows that the tallow is from .125 to .143 of the dead weight, and .08 of the live weight; the hide is .05 of the live weight; and the other offals are from .33 to .25 of the live weight. Thus, then, when the tallow is 13 per cent of the dead weight, it is 8 per cent of the live weight.

6149. *Beef* is the staple animal food of this country, and it is used in various states,—fresh, salted, smoked, roasted, and boiled. When intended to be eaten fresh, “the ribs will keep the best, and with care will keep 5 or 6 days in summer, and in winter 10 days. The middle of the *loin* is the next best, and the *rump* the next. The *round* will not keep long, unless salted. The *brisket* is the worst, and will not keep longer than 3 days in summer, and a week in winter.”*

6150. In cooking, a piece of beef, consisting of four of the longest ribs, and weighing 11 lb. 1

* *The Experienced Butcher*, p. 171.

oz., was subjected to roasting by Mr Donovan, and it lost during the process 2 lb. 6 oz., of which 10 oz. were fat, and 1 lb. 12 oz. water dissipated by evaporation. On dissection, the bone weighed 16 oz., so that the weight of meat fit for the table was only 7 lb. 11 oz. out of 11 lb. 1 oz. It appears that when the butchers' price of sirloins is 8½d. per lb., the meat cost when roasted 1s. 1¼d. per lb., at a loss of 19½ per cent.*

6151. The usual mode of preserving beef is by salting; and when intended to keep a long time, as for the use of the shipping, it is always salted with brine; but for family use it should be salted dry with good Liverpool salt, without saltpetre; as brine dispels the juice of the meat, and saltpetre only serves to make the meat dry, and give it a disagreeably unnatural red colour.

6152. Salted beef cured with wood smoke is converted into ham, and is highly relished. The cured beef of Glasgow, and the hung beef of Hamburg, are both relished.

6153. Beef, whether fresh or salted, is now admitted into this country from abroad duty free. Beef salted, or fresh, or corned, imported, amounted in—

	1847. Cwt.	1848. Cwt.	1849. Cwt.
Salted not corned,	112,386	114,387	144,638
Fresh, or slightly salted,	5,011	7,623	5,279
Meat, salted or fresh, not otherwise described,	3,114	4,436	..
	<u>120,511</u>	<u>126,446</u>	<u>149,917</u>

6154. The tierce of salted beef for the navy contains 300 lbs., consisting of 38 pieces of about 8 lb. each.

6155. Cattle are useful to man in various other ways than affording food from their flesh, their offals of tallow, hides, and horns, forming extensive articles of commerce. Of the *hide*, the characteristics of a good one, for strong purposes, is strength in its middle or *butt*, as it is called, and light on the edges or *offal*. A bad hide is the opposite of this, thick in the edges and thin in the middle. A good hide has a firm texture, a bad one loose and soft. A hide improves as the summer advances, and it continues to improve after the new coat of hair in autumn, until November or December, when the coat gets rough from the coldness of the season, and the hide is then in its best state. It is surprising how a hide improves in thickness after the cold weather has set in. The sort of food does not seem to affect the quality of the hide; but the better it is, and the better cattle have been fed, and the longer they have been well fed, even from a calf, the better the hide. From what has been said of the effect of weather upon the hide, it seems a natural conclusion that a hide is better from an ox that has been fed in the open air than from one fed in a byre. Dirt adhering to a hide

injures it, particularly in byre-fed animals; and anything that punctures a hide, such as *warbles*, (3803,) is also injurious. The best hides are obtained from the West Highland breed of cattle. The Short-horns produce the thinnest hides, the Aberdeenshire the next, and then the Angus. Of the same breed, the ox affords the strongest hide; but as hides are applied to various uses, the cow's hide, provided it be large, may be as valuable as an ox's. The bull's hide is the least valuable.

6156. Hides are now imported free. The quantities that were imported are as follows, in—

	1847. Cwt.	1848. Cwt.	1849. Cwt.
Dry,	172,296	132,395	143,490
Wet,	429,085	414,886	535,295
	<u>601,381</u>	<u>547,281</u>	<u>678,785</u> ‡

6157. Hides, when deprived of their hair, are converted into leather by infusion of the astringent property of bark. The old plan of tanning used to occupy a long time; but such was the value of the process, that the old tanners used to pride themselves in producing a substantial article. More recent discoveries have prompted tanners to hasten the process, much to the injury of the article produced. Strong infusions of bark make leather brittle; 100 lb. of skin, quickly tanned in a strong infusion, produce 137 lb. of leather; while a weak infusion produces only 117½ lb., the additional 19½ lb. serving only to deteriorate the leather, and cause it to contain much less textile animal solid. Leather thus highly charged with tannin is so spongy as to allow moisture to pass readily through its pores, to the great discomfort and danger of persons who wear shoes made of it. The proper mode of tanning lasts a year, or a year and a half, according to the quality of the leather wanted, and the nature of the hides. A perfect leather is recognised by its section, which should have a glistening marbled appearance, without any white streaks in the middle. § Leather is applied to many important purposes, being made into harness for agricultural and other uses. It is used to line the powder magazines of ships of war; to make carding machines for cotton and other mills; belts to drive machinery; to make soles of shoes; and, when japanned, to cover carriages. Calves' leather is used in bookbinding. The hair taken off hides in tanning is employed to mix with plaster, and is surreptitiously put into hair mattresses.

6158. Tanned hides are admitted free of duty. The quantity imported was as follows, in—

	1847. Lb.	1848. Lb.	1849. Lb.
Tanned, tawed, cured, or dressed,	1,430,950	1,248,647	1,809,755‡

Leather manufactured in any way pays a duty, on importation, of L.10 per L.100 value.

* Donovan's *Domestic Economy*, vol. ii. 274. † *Parliamentary Return*, Feb. 12, 1850. ‡ *Ibid.*
§ *Ure's Dictionary of the Arts—arts. Leather and Tanning.* ¶ *Parl. Ret.* Feb. 12, 1850.

6159. "The principal substances of which glue is made," says Dr Ure, "are the paring of ox and other thick hides, which form the strongest article; the refuse of the leather-dresser: both afford from 45 to 55 per cent of glue. The tendons, and many other offals of slaughter-houses also afford materials, though of an inferior quality, for the purpose. The refuse of tanneries—such as the ears of oxen, calves, sheep, &c.—are better articles; but parings of parchment, old gloves, and in fact animal skins in any form, uncombined with tanning, may be made into glue.* Glue, and the clippings of which it is made, are now imported free.

6160. *Ox-tallow* is of great importance in the arts. Candles and soap are made of it, and it enters largely into the dressing of leather and the use of machinery. It consists of 76 parts of stearin and 24 parts of olein. The duty on importation is now reduced to 1s. 6d. per cent from foreign countries and 1d. per cent from the British colonies. The quantity imported was as follows in,

	1847. Cwt.	1848. Cwt.	1849. Cwt.
Tallow,	1,099,275	1,498,359	1,468,719†

6161. The *horns* of oxen and sheep are used for many purposes. "The horn consists of two parts: an outward horny case, and an inward conical-shaped substance, somewhat intermediate between indurated hair and bone," called the *flint* of the horn. "These two parts are separated by means of a blow on a block of wood. The horny exterior is then cut into three portions by means of a frame saw. The lowest of these, next the root of the horn, after undergoing several processes by which it is rendered flat, is made into combs. The middle of the horn, after being flattened by heat and its transparency improved by oil, is split into thin layers, and forms a substitute for glass in lanterns of the commonest kind. The tip of the horn is used by the makers of knife-handles and of the tops of whips, and for other similar purposes. The interior, or core of the horn, is boiled down in water. A large quantity of fat rises to the surface; this is put aside, and sold to the makers of yellow soap. The liquid itself is used as a kind of glue, and is purchased by the cloth-dresser for stiffening. The bony substance which remains behind is then sent to the mill, and, being ground down, is sold to the farmers for manure. Besides these various purposes to which the different parts of the horn are applied, the clippings which arise in comb-making are sold to the farmers at about 1s. per bushel. The shavings which form the refuse of the lantern-makers are also sold as manure.‡ A few of them are cut into various figures, and painted and used as toys, which cast up when placed in the palm of a warm hand. Horn, as is well known, is easily rendered soft and pliant in warm water; and by this, and the property of adhesion like glue, large plates of horn can be made by cementing together the edges of small

pieces rendered flat by a peculiar process, as a substitute for glass. For this purpose, the horns of goats and sheep are preferred, being whiter and more transparent than those of any other animal. Imitation of tortoise-shell can be given to horn by the use of various metallic solutions. Horn, also, when softened, can be imprinted with any pattern by means of dies. Horn is now admitted duty free.

6162. *Mutton*.—Of the relative weights of offal and meat afforded by sheep, instances are recorded, and of a fat Southdown wether they were these, the live weight being 13 stone, 10 lb.—

MEAT.		lb.	oz.
Fore quarter,		29	0
Ditto,		28	12
Hind quarter,		33	8
Ditto,		32	0
		123	4

OFFAL.		lb.	oz.
Blood and entrails,		13	0
Caul and loose fat,		21	4
Head and pluck,		8	12
Pelt,		15	12
		53	12

6163. The comparative weights of different breeds of the same class and age are as follows:—

Breed.	Age. Months.	Weight per quarter.		Wool. Lb.
		Lb.	Lb.	
Long wools,	16	52	14	
Leicesters,	16	46	11	
Southdowns,	16	36	8	
Long-wools,	40	72	15	
Leicesters,	40	56	11	
Southdowns,	40	46	8	

6164. There is little doubt that, in the Leicester breed, the meat bears a higher proportion to the offal than in any other. In the case of a Southdown in (5939) the meat is about $\frac{2}{3}$ and the offal $\frac{1}{3}$ of the whole weight, or, more nearly, the meat is as 123½ : 182, and the offal as 58½ : 182. And in the same breed it has been said that the proportion of bone is as low as 1 oz. to 1 lb. flesh; but I much doubt this, because Mr Donovan found in a leg of mutton, which is the most fleshy part of the carcass in proportion to the bone in it, weighing 9¼ lb., 16 oz. of bone; another of 9 lb. 6 oz., 15 oz. of bone; and a leg of small Scotch mutton of only 6 lb. weight, afforded 10¼ oz. of bone.

6165. A rule is mentioned by Mr Ellman of Glynde, in Sussex, by which the age of mutton may be ascertained by certain marks on the carcass, and it is an infallible one. He says, "Observe the colour of the *breast-bone* when a sheep is dressed—that is, where the breast-bone is separated—which, in a lamb, or before it is 1 year old, will be quite red; from 1 to 2 years

* Ure's Dictionary of the Arts—art. *Glue*. † Parliamentary Return, February 12, 1850.
‡ Ure's Dictionary of the Arts—art. *Horn*.

old, the upper and lower bone will be changing to white, and a small circle of white will appear round the edges of the other bones, and the middle part of the breast-bone will yet continue red; at 3 years old, a very small streak of red will be seen in the middle of the 4 middle bones, and the others will be white; and at 4 years, all the breast-bone will be of a white or gristly colour.”*

6166. The average loss on *boiling* legs of mutton is 10 per cent; so that, if the butchers' price were 6d. per lb., the boiled mutton would cost 6½d. The average loss of *roasting* legs of mutton is 27 $\frac{1}{8}$ per cent; so that, at the butcher's price of 6d. per lb., the roasted mutton would cost 7½d. per lb. These results differ considerably from those obtained by Professor Wallace, who, in the case of *boiling* 100 lb. of mutton, detected a loss of 21½ per cent, instead of 10 per cent; and in that of *roasting* 100 lb. the loss was 31½ instead of 28 per cent. These discrepancies might perhaps be easily explained, were we acquainted with every particular connected with both sets of experiments, such as the state of the fatness of the meat before being cooked, for fat meat will lose more weight than lean in the dressing. Of his experiments, Mr Donovan says, “I used meat of sufficient, but not unprofitable fatness, such as is preferred by families; the meat was in all cases a little rare at its centre, and the results were determined with the utmost care.”†

6167. Good *ham* may be made of any part of a carcass of mutton, though the *leg* is preferred, and for this purpose it is cut in the English fashion, fig. 561. Wether mutton is used for hams, because it is fat; but tup mutton makes the largest and highest flavoured ham, provided it be cured in spring, when it is only in season.

6168. Where Leicester sheep are bred, and the farmer kills his own mutton, suet will accumulate beyond what can be used for domestic purposes. As long as it is fresh it should be *rynded* or *rendered*, because the fibrous and fleshy matter mixed with it soon promotes putrefaction. To do this it should be cut in small pieces, removing only fleshy matter. It is then put in an earthen jar, which is placed within a pot containing warm water, at the side of the fire to simmer, and not to boil. As every portion put in is melted, another succeeds, until the whole is melted; and the melted mass should be very frequently stirred. Suet melts at from 98° to 104° Fahr. After being fused a considerable time, the membranous matter comes to the top, and is taken off; and when obtained in quantity and squeezed, it constitutes the *cracklings* which are sometimes used for feeding dogs. The purified suet may then be poured through a cullender, into a dish containing a little cold water, upon which it consolidates into a cake; and the cakes are either sold to the candle-makers, or candles taken in exchange.

6169. Mutton suet consists of about 77 parts of stearin and 23 of elein—the former being solid, the latter fluid. The specific gravity of suet is 0.936. When a piece of solid suet is broken, innumerable minute granules separate from the mass; and these, when examined by the microscope, exhibit definite forms, being polyhedral, bounded within the limits of a sphere, or oblong, of very firm consistence, and when measured, give dimensions varying in length from $\frac{1}{80}$ to $\frac{1}{50}$, and in breadth from $\frac{1}{80}$ to $\frac{1}{50}$ part of an inch.‡ The constituent parts of suet, according to Chevreul, are carbon, 78.996, hydrogen, 11.700, and oxygen, 9.304.§

6170. Mutton suet is used in the manufacture of common *candles*, with a proportion of ox tallow. Minced suet, subjected to the action of high-pressure steam in a digester at 250° or 260° Fahr., becomes so hard as to be sonorous when struck, whiter, and capable, when made into candles, of giving very superior light. Stearic candles, the invention of the celebrated Guy-Lussac, are manufactured solely from mutton-suet.

6171. But the products of sheep are not merely useful to man, they also afford him luxuries. The skin of sheep is made into leather, and, when so manufactured with the fleece on, makes comfortable mats for the doors of our rooms, and rugs for our carriages. For this purpose the best skins are selected, and such as are covered with the longest and most beautiful fleece. Tanned sheep-skin is used in coarse bookbinding. White sheep-skin, which is not tanned, but so manufactured by a peculiar process, is used as aprons by many classes of artisans, and in agriculture, as gloves in harvest; and when cut into strips, as twine for sewing together the leathern coverings and stuffings of horse-collars. Morocco leather is made of sheep-skins as well as of goats', and the bright red colour given to it is by cochineal. Russia leather is also made of sheep-skins, the peculiar odour of which repels insects from its vicinity, and resists the mould arising from damp, the odour being imparted to it in currying, by the empyreumatic oil of the bark of the birch tree. Besides soft leather, sheep-skins are made into a fine, flexible, thin substance, known by the name of parchment; and though the skins of all animals might be converted into writing materials, only those of the sheep and she-goat are used for parchment. The finer quality of the substance called vellum is made of the skins of kids and dead-born lambs, and for its manufacture the town of Strasburg has long been celebrated.

6172. It would appear that there are circumstances which naturally limit the power of re-acton and absorption in the skin of the sheep. It is surrounded by a peculiar secretion, adhesive and impenetrable to moisture—the yolk—destined chiefly to preserve the wool in a soft, pliable, and healthy state. On this account there

* *British Husbandry*, vol. ii. p. 486.

† *Raspail's Organic Chemistry*, p. 238.

‡ *Donovan's Domestic Economy*, vol. ii. 289.

§ *Liebig's Animal Chemistry*, p. 300.

can be little perspiration going forward from the skin, and hence few diseases are referable to change in that reaction. Also there is little radiation of animal heat, both on account of the interposition of the yolk, and of the non-conducting power of the wool. The caloric disengaged from a sheep is only one-seventh of that from man, though its weight is one-third of that of his, consequently only half the animal heat radiates from a sheep, from a given surface, that does from man. This it is which enables the ewe and the lamb to endure the colds of spring without detriment; and also, when sheep are crowded together in an open fold, no unnatural or dangerous state of heat is thereby produced.

6173. In the manufacture of some sorts of cords from the intestines of sheep, the outer peritoneal coat is taken off and manufactured into a thread to sew intestines, and make the cords of rackets and battledores. Future washings cleanse the guts, which are then twisted into different-sized cords for various purposes. Some of the best known of those purposes are whip-cords, hatters' cords for bowstrings, clockmakers' cord, bands for sheaves, and fiddle and harp strings. Of this last class of cords—the source of one of our highest pleasures—it has long been subject of regret that musical strings manufactured in England should be so inferior in goodness and strength to those of Italy; and the reason assigned is, that the sheep of Italy are both smaller and leaner than those of this country. The difficulty lies, it seems, in making the treble strings from the fine peritoneal coat, their chief fault being weakness, whence the smaller ones are hardly able to bear the stretch required for the higher notes in concert-pitch; maintaining, at the same time, in their form and construction that tenuity or smallness of diameter which is required to produce a brilliant and clear tone.* However insignificant this subject may appear in the estimation of some, it is worth attending to by those interested in enhancing the profits of our native products, especially when it is considered that harp-strings sell as high as from 6d. to 2s. apiece.

6174. *Pork*.—Much less difference exists between the live and dead weight of pigs than any other species of stock, because no skin is taken off, and the head is always left with the carcass, and only the fat and entrails removed. The difference of live and dead weights are given below, on a few out of a large number of pigs slaughtered by Mr M. Sandford, St Martin's Farm in 1849, in single and combined carcasses:—

Live weights.	Dead weights.	Live weights.	Dead weights.
lb.	lb.	lb.	lb.
1 99	1 39	2 38	5 23
1 91	1 31	2 30	
1 99	1 35	2 35	

6175. Mr Donovan found a hand of salt pork, weighing 4 lb. 5 oz., to lose in boiling 11 oz. The

bone weighed 9 oz.; the meat was 3 lb. 1 oz. If the first cost of the meat was 7½ per lb., the meat alone, when duly boiled, cost 10¼d., and with the bone 9d. per lb. The loss in boiling salt pork is consequently 13½ per cent.

6176. *Pickled pork* derives its name from the mode in which pork is cured in a strong brine or pickle of salt and water. Immense quantities of pork are pickled, for home and foreign consumption. The navy tierce of pork consists of 80 pieces of 4 lb. each.

6177. *Pork ham* being a standing dish at the farmer's table, a number of fat pigs are slaughtered and cured into ham every year, according to the size of the farmer's household, (2866.)

6178. A common practice is to cut out the hams and cure them by themselves, and then to take out the ribs, which are roasted as spare-ribs, and the flesh and fat cured as a *gammo* or *fitch*,—an old English favourite. Ancient custom makes many reconciled to this practice, and in the case of people preparing bacon for sale, it may be profitably followed; but for family use, when the customs of markets are not studied, hams are better kept in whole sides until used, and, when used, cut out in pieces of the sizes required. The fitches will certainly keep safer with the ribs attached to them than when left bare. Fitches are apt to become reasty, yellow-coloured, and rank-flavoured, when shut up in boxes, or kept in damp places, wanting circulation of the air. They should be hung up like hams in a cool dry apartment, where the air is amply circulated.

6179. *Pork hams* are often smoked. The process of smoking, however, is troublesome to the farmer, who has not premises suitable for conducting it. The same end will be served by steeping the bacon a few hours in wood-vinegar—the pyroligneous acid.

6180. From experiment, it was ascertained by Mr Donovan, that, if the first cost of ham be 10¼d. per lb., the meat, duly boiled, skinned, and browned, will cost 1s. 1¼d. per lb.; the loss thereby being consequently 12½ per cent.†

6181. Hog's lard is rendered in exactly the same manner as mutton suet (6168) but as lard is liable to become rancid, yellow-coloured, and acquire a strong smell when exposed to the air, it is usually tied up in bladders. For this purpose it is allowed to cool a while, after it is melted, and the bladder, a pig's or calf's, being made ready by being thoroughly cleaned and turned outside in, is filled with the lard by a funnel, and tied up. Lard "melts completely at 99° Fahr., and then has the appearance of a transparent and nearly colourless fixed oil. A thermometer placed in it sinks gradually to 80°. The lard then begins to congeal, and the thermometer remains at 80° all the time of congealing, which occupies several minutes. It is clear from

* Ure's *Dictionary of the Arts*—arts. *Fat*—*Leather*—*Parchment*—*Catgut*.

† Donovan's *Domestic Economy*, vol. ii. p. 279 and 287.

this, that 80° is the melting point of hog's lard. Its specific gravity at 102° is 0.9028 ; at 60°, it is 0.9302. . . . It consists of elein 62 parts, and of stearin 38 parts. . . . When subjected to pressure between folds of blotting paper, the elein is absorbed, while the stearin remains."* For domestic purposes, good hog's lard is better than bad butter for frying fish ; but quite unfit for pastry, and is improperly used in that way on the score of economy.

6182. Hog's skin is usually thick, and, when tanned, its great toughness renders it valuable for the seats of riding saddles, and for powder flasks.

6183. Hog's bristles are formed into brushes for painters and artists, and into brooms for domestic use. The finest and longest bristles are imported from Finland, where the pigs are always lean, their loins being tucked up like those of the greyhound.

6184. The pork imported into this country was as follows, in—

	1847. Cwt.	1848. Cwt.	1849. Cwt.
Pork salted,	235,798	254,070	347,352
„ fresh,	101	61	924
	<hr/> 235,899	<hr/> 254,131	<hr/> 348,276

6185. The hams imported were, in—

	1847. Cwt.	1848. Cwt.	1849. Cwt.
Hams,	17,203	7,717	12,282 †

6186. Pork is admitted free ; and hams pay a duty of 7s. per cent from foreign countries, and 2s. per cent from the British possessions.

6187. Fat is very generally distributed in the animal frame. It is abundant under the skin, in the cellular membrane, round the kidneys, in the folds of the omentum, at the base of the heart, in the mediastinum, the mesenteric web, as well as upon the surface of the intestines, and among many of the muscles. It varies in consistence, colour, and smell, according to the animal from which it is obtained. Thus, it is generally fluid in the cetaceous tribes, soft and rank-flavoured in the carnivorous, solid and nearly scentless in the ruminants ; usually white and copious in well-fed young animals, yellowish and more scanty in the old. Its consistence varies also according to the organ of its production, being firmer under the skin and in the neighbourhood of the kidneys than among the movable viscera. Fat forms $\frac{2}{5}$ of the weight of a healthy animal ; but as taken out by the butcher it is not pure, for, being of a vesicular structure, it is always enclosed in membranes, mixed with blood, blood vessels, lymphatics, &c.

6188. In close warm weather meat often becomes tainted. Any plan that can save this loss in domestic economy is entitled to a trial. Dr

Stenhouse of Glasgow recommends this one :—
 “ I placed a small plate containing a little creosote immediately under each piece of meat as it hung suspended in the larder, and covered both over with a cloth. The creosote soon gave off vapours which formed an antiseptic atmosphere around the meat, and kept it quite fresh three or four days longer than it would otherwise have been. If the plate is gently heated before the creosote is put into it, the vapours rise more quickly, and if the additional precaution is also taken of suspending the meat in a wooden box or earthen jar which can be closed with a lid, the beneficial effect is still more discernible. I have tried this process during the greater part of a summer with invariable success, and a butcher, who also tried it on a larger scale in his stall, was equally convinced of its efficacy. The meat, when cooked, has not the slightest smell or taste of creosote. There is also another advantage attending the use of creosote. Its smell is so disagreeable to flies that it effectually frees a larder from the presence of these noxious insects. The same quantity of creosote may be used for several weeks, but on being long exposed to the air it loses most of its smell, and is partly changed into a species of resin.”

6189. On considering the facility with which the use of chloroform induces insensibility in the human frame, it has occurred to me that it might be usefully applied in rendering animals insensible before slaughtering them ; and the only doubt that arose in my mind regarding its use in this way was of its imparting any flavour to the flesh, or of accelerating its decay, or of being too expensive for ordinary use. On inquiring of Professor Simpson of Edinburgh, the discoverer of this extraordinary substance, he informs me that it imparts no flavour to the flesh, either of sheep, pigs, or fowls ; and so far from accelerating its decay, it rather preserves it a considerable time. The expense is not great : an ordinary ox may be rendered insensible for 2s., and a sheep and a pig for 1s. each. It may be administered by means of a cloth applied to the nostrils and month. Although chloroform would thus be too expensive for the general slaughtering of animals, it might be used by farmers to place beyond the feeling of pain all the animals they require to slaughter, and, by thus rendering them entirely passive, the operation of slaughtering could be performed without the risk of injuring the flesh by bruises of the slightest description.

6190. The flesh of the domesticated animals becomes poisonous under certain states. “ There is no doubt,” observes Dr Taylor, “ that *partial decay* may render unwholesome and injurious the flesh of the most healthy animals ; and it is by no means improbable that, among the poor of large cities, the secret sale of decomposed and unwholesome meat is a very frequent cause of disease and death.” †

6191. The flesh or muscle of animals consists

* Thomson's *Animal Chemistry*, p. 134.

† *Parliamentary Return*, 12th February 1850.

‡ Taylor *On Poisons*, p. 561.

chiefly of two component parts, the fibrin and the albumen. When the fibrin predominates, which it does when the flesh is very lean, and has not been fattened at all, the meat is tough and hard. When the albumen bears a considerable proportion of the flesh between the threads of fibrin, which it always does when the animal is in fair condition and has been fattened, the flesh is tender and juicy.

6192. Recent experiments of Liebig have brought to light some very curious differences existing between the contents of flesh and of the blood, although the latter may be said to traverse every portion of the former. I shall best give you an idea of those facts, in the words of Professor Gregory, who first introduced them to the notice of the English reader. There is a "great preponderance," he observes, "of phosphate of potash and chloride of potassium in the juice of flesh, while in the blood and lymph which circulate through the muscles, it is phosphate of soda and chloride of sodium which prevail. The juice of flesh is always strongly acid, while the blood and lymph are decidedly alkaline. There is an abundant supply of lactic acid in the juice of flesh, while it cannot be detected in the urine. But perhaps the most interesting observation, next to the discovery of kreatine as a constant ingredient of flesh, is of kreatinine, a powerful base in the juice of the flesh, and of both in urine, which is a demonstration complete, as it appears to me, of the true function of the phosphate of soda in the blood. This function, that of absorbing carbonic acid and giving it out in the lungs, is here shown to depend entirely on the minute chemical character of the salt in question; and we now see how it happens that phosphate of soda is essential to the blood, and cannot be replaced by phosphate of potash or salt, which, although in many points analogous, differs entirely from phosphate of soda in its tendency to acquire an acid instead of an alkaline reaction, and in its relation to carbonic acid. The same remark applies to the action of common salt in phosphate of soda, which satisfactorily accounts for the presence of phosphate of soda in the blood of animals whose food contain only phosphate of potash, but which either find common salt in their food, or obtain it as an addition."*

6193. Another recent discovery of Liebig's indicates the causes of the motion in the juices of the animal body, which he partly ascribes to the action of the atmospheric pressure.†

ON THE POINTS TO BE AIMED AT IN BREEDING THE MOST PERFECT FORMS IN LIVE STOCK.

6194. We have now arrived at the most difficult branch of farming, and the highest aim which the farmer wishes to attain in

breeding live stock, which is, to produce the most perfect animal that will yield the largest profit. It is easy to possess a flock or a herd which will propagate its kind, as is evinced in the actual condition of many of the flocks and herds abounding in the country. It is easier to do this than to cultivate arable land for the purpose of raising grain, for this requires pretty constant attention at the seasons of seed-time and harvest; whereas a flock or herd of neglected animals will keep themselves in life, if food be within their reach, and will even propagate their kind if the sexes are not kept asunder.

6195. I suspect that the principles by which the highest aim alluded to is to be attained is not thoroughly understood by breeders; for I imagine that our best stock has been brought to its present state of perfection by the exercise of individual taste and judgment—by gratifying the eye and satisfying the mind, rather than by the unerring guidance of any fixed principle on the subject. However this may be, observation of the operations of nature is sufficient to acquaint us that the pleasing symmetry in the body of an animal, its aptitude to grow and fatten, are dependent on fixed laws which regulate the animal functions; and could we but become acquainted with these, we might pursue the breeding of our stock with the utmost certainty of success.

6196. From what I have stated, you will not expect from me so particular an explanation of the principles of breeding as I have given of the methods of conducting the operations of the field. Suffice it to give you a few of the ordinary rules which guide the breeder in the treatment of his stock, with a view to attaining the high aims referred to; and for the better understanding of which, I have selected groups of animals as examples, in whose points you should have confidence, because they have been faithfully selected and taken from life, from individuals deemed excellent by competent judges.

6197. The great aim of breeders is, that their stock shall exhibit beautiful symmetry—possess robust constitution—

* Liebig's *Chemistry of Food*, Preface, p. viii.

† Liebig *On the Motion of the Juices of the Animal Body*, Preface, p. ix.

and acquire a disposition to attain early maturity, without which properties good health, fine quality of flesh, and sufficiency of fat, cannot be insured. Let us consider what each of those properties means, and then attend to the *points* in animals, which always accompany those properties.

6198. *Symmetry*.—The figure desiderated in the matured and fatted animal is the geometric solid named the parallelepiped, because it not only affords a figure that may be proportionally beautiful, but it contains a large capacity of contents within small dimensions. Of course it is not to be supposed that the outline of any animal frame should present the sharp edges and projecting angles of a geometric figure, but it is quite possible to identify the similarity of the animal body to the mathematical solid. In the attainment of this similarity, it is fortunate for the breeder of stock that his taste and interest coincide; for, if his eye is not pleased with the form of the animal he has bred, certain it is that the animal will not become a valuable one to him.

6199. In order to satisfy one's mind on the identity of shape of the animal frame and the geometric solid named, we have only to compare the figures of the animals usually reared for disposal from the farm with the said solid. Fig. 296 represents an ox fit to be disposed of at market as a matured animal. The wooden rectangular frame, which is placed against its side, and which is similar to the side of a parallelepiped of the same dimensions as the ox, circumscribes in almost every point the outline of the animal; and that outline is no more redundant in one place, and deficient in another, than might be expected on comparing the form of a living creature with a mathematical figure.

6200. But a parallelepiped has not sides alone, it has also ends. Let us see whether the figure of the same ox also answers to these, when viewed from behind and before. Fig. 297 shows the application of the end of the geometric solid, in the form of a rectangular square, against the hind part of the ox; and a single glance makes it evident that the same remarks apply to this view of the figure as to that of the side. Still further, fig. 298 applies the same

rectangular square to the fore part of the same ox; and although the frame is not so fully filled up in this view as in the two former, it is clear that the general contour of the animal in this view also is very similar to both the preceding. The width between the shoulders of an ox from *a* to *a* is always a little less than between the hooks *a* to *a* in fig. 297; although the ribs are always as full in a well-formed animal.

6201. The parallelepiped has an upper surface and a base, as well as sides and ends. Fig. 299 shows the rectangular frame of fig. 296, applied to the back of the ox, which fills it as fully as might be expected—the only spaces left vacant being at the angles.

6202. So far, then, the contour of the frame of a matured ox tallies very nearly with the lines of a regular mathematical solid. It will be observed that the form of the wooden frame, in figs. 296 and 299, is a rectangle, and that of figs. 297 and 298 is a square, and the proportion which they bear to one another is that the rectangle comprehends two of the squares; so that the conclusions we should draw in reference to the figure of the ox is, that the length of the body to the shoulder point is twice its breadth, and twice its depth. The lines which fill up the contour of the ox are explained in (3616) to (3621.) The height of the shoulder top is about one inch more than the rump. The void space below the belly fills up $\frac{1}{3}$, and the body $\frac{2}{3}$, of the area included between the line of back and the ground.

6203. The rectangular wooden frame applied to the side, before, behind, and upon the back of a matured fat sheep, will bring out very similar results to the ox. Plate IX. contains the portraits of three wethers which were brought to the Edinburgh market for sale, of the Leicester, Cheviot, and Black-faced breeds; and it will be observed that one and all of them have bodies of the same form as the ox. The clipped top, fig. 330, illustrates clearly the same rule.

6204. The draught gelding, figured in Plate XII., maintains a similar form to the ox in the body, and fully corroborates the remarks I have made above. The

length of the body is twice its depth. The void space below the belly to the ground is equal to the depth of the body. The length of the neck to the withers is equal to the depth of the body from the withers. The distance from the elbow to the fetlock joint is equal to that of the withers.

6205. The same test applied to pigs may be seen in fig. 438, where the rectangular frame is about filled up except at two angles, which are more vacant than with the ox, the sheep, or the horse; but the lines of the rump of a pig are always more abrupt than those of any other of the domesticated animals, (5136.)

6206. *Robustness of constitution.*—The indications of good health and strength of constitution are—strong, broad, flat bones in the legs, with the sinews thick and round, and distinctly developed, the whole being closely covered with skin. This condition of the legs is what is termed *clean*. The eye is full and clear. The skin of the nose, in the case of cattle, sheep, and pigs, is bedewed with moisture. The skin is covered closely with long fine hair. The surface of the horn on the feet and head oily and shining, and the junction of the hair and horn growthy. The hair of the tail of the ox and of the horse long, shining, with a tendency to curl. The wool of sheep wavy, greasy, interlaced, and of fine quality. The animal spirits lively, the senses acute, and the instinct sagacious. The appetite ready, digestion good. The body enduring of fatigue, and little susceptible of the changes of the weather. These conditions are maintained by kind treatment, comfortable lodging, and abundance of food.

6207. A delicate constitution is indicated by the opposite properties. The skin is thin, and covered with scanty hair or open wool. With such a covering the animal is affected by the least change of weather, overcome with the heat of summer, feels uneasy in the cold of winter, and is chilled by every shower that falls. A very small bone, however clean, is always accompanied with a reduced size of carcass. Thick and round bone gives a clumsiness to the limbs and head, and is

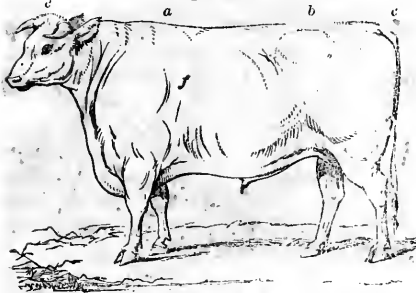
invariably accompanied with dulness of spirit and want of action. A thin-skinned and thick-boned animal is ill to maintain in condition. A fit of indigestion frequently overtakes thin-skinned animals, and their condition in consequence varies. Thick-boned animals never seem to relish their food, are indifferent to everything that concerns them, and are dull feeders. A flat-ribbed thin-bodied animal is more delicate than a round-ribbed one.

6208. *Disposition to attain early maturity.*—The most prominent indication of this disposition is a loose, thick, mellow skin, as if floating upon a stratum of fat below; and such a skin is invariably covered with long, soft, mossy-feeling hair, bearing a decided colour. A firmness of texture over the whole body is essential to a disposition to fatten; no fat encumbers the bones of the legs and of the head. All the extremities, the limbs, head, and tail are small, fine, and tapering from the body. The eye is prominently set in the head, and with a placid expression. The forehead is broad. The ears are sensible to every new sound. The muzzle is sharp, the nostrils distended, the jaws distinct and clean. The muscles are broad and flat. The blood-vessels large and full. The chest is broad, and the tail flat at the top, and broad and tapering to the tuft of hair. The line of the back is straight and level, and the ribs round. A back high above the level is narrow, and is accompanied with flat ribs and long narrow face, which are both indicative of a want of disposition to fatten. When the back is below the level, the fat and flesh are mostly put upon the under part of the carcass, and the tallow increases in the interior. The flanks and cod are then thick and fat. In such a configuration the fore quarters are larger than the hind. Such an animal evinces a disposition to fatten, but lays on coarse pieces. When the curved lines abound over the body and play into one another, giving a brilliancy to the surface, while the sweeping lines of the contour, with the tapering fineness of the extremities, the pleasing countenance, and the joyous spirit, a symmetry, state of health, and disposition to improve are conjoined, that afford the highest satisfaction and profit to the breeder.

DESCRIPTION OF THE ANIMALS, WHOSE PORTRAITS ARE GIVEN IN THE PLATES.

6209. Let us apply these *points* to the animals whose portraits occupy the plates given in this work—and first let us take the examples of the Short-horn cattle; and of these we shall first take the ox as the type of the class, being the most common state we find the feeding cattle on a farm. Fig. 564 is a representation of the

Fig. 564.



THE SHORT-HORN OX.

portrait of the ox given in Plate X. This is a well-bred Short-horn ox, bred and fed by Mr Wilson of Cumledge, near Duns in Berwickshire, who has long been a successful breeder of Short-horn steers, (1153.) His stock comes to maturity, and is fattened off at two years old, when many out of 50 in number attain the weight of 70 stones. This particular ox was only 1 year 11 months old when his portrait was taken; and he was afterwards exhibited at the Highland and Agricultural Society's show at Berwick-upon-Tweed, in October 1841. He was roan in colour, with a good deal of white on the head, gullet, breast, under part of the belly, round the girth, and upon the rump and buttock. His head was remarkably fine, broad above the eyes, having a pleasant countenance, full eyes, and small slouching sharp-pointed brown horns. Besides a fine head, he had a straight back, round rib, deep flank, and full neck-vein. His limbs were remarkably clean. He was in high health. His principal measurements were, from the head *c*, to the shoulder top *a* 27 inches, from the shoulder *a* to a line across the hooks *b*, 32 inches, from the hooks *b* to the tail-head *c*, $21\frac{1}{2}$ inches, in all 6 feet 9 inches; and the girth of the body behind the

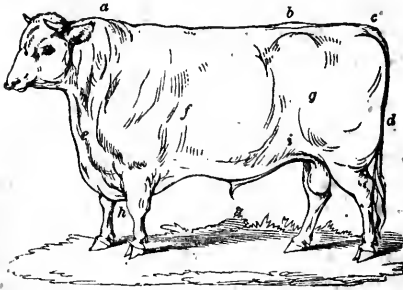
shoulder at *f* 7 feet 3 inches. His measurement for beef was 4 feet 6 inches in length, by 7 feet 3 inches in girth, fig. 300, equal to 56 stones; so I should say, from these proportions, that this ox was rather too short for a perfectly symmetrical figure, and was rather heavier in the hind than in the fore quarter.

6210. In Plate XI. is the portrait of a red and white Short-horn bull. The red was remarkably rich in colour, and the white was confined to the girth on the near side, the under part of the brisket, and of the belly, and on the scrotum. He was bred by the late Mr George Brown at Whitsome Hill, in Berwickshire. He was got by a red and white bull belonging to Mr Robertson of Ladykirk in that county, named *Valentine*.* At that period, Mr Robertson's stock of Short-horns was in its glory. The dam of this bull was got by a red bull, never named, bred by the late Mr Thomas Smith when at Grindon, in Northumberland, and was a son of his old roan bull Duke; and at that period few farmers possessed so high a bred stock as Mr Smith; his steers being then unrivalled for beauty and weight. The grand-dam was one of twin quey-calves produced by a quey, purchased in calf by Mr Brown from the late Mr Mason of Chilton. One of the twin-calves, when a 2-year old quey, Mr Brown sold to the late Duke of Buccleuch for 50 guineas, and the other he retained for himself. I purchased this bull when one year old from Mr Brown for 20 guineas, and kept him at Balmadies, in Forfarshire, for 8 years, during which time he proved himself a sure and excellent calf-getter, and evinced a gentleness of disposition to every person who approached him, in a degree remarkable for a bull. He had many good points—small head, full lively eye, small, fine, white horn. He was completely filled up behind the shoulder, at *f*, fig. 565, a point in which many otherwise fine bulls are deficient. He had a long quarter across *g*, a difficult point to attain in a bull, carrying the flesh to the hocks *d*; a very thick flank *i*; the ribs very round, which, with the upfilling behind the shoulder at *f*, made the line *straight* from the shoulder point *e* along the rib at *f*, and the buttock *g* to

* Coates' *Herd Book*, vol. i. p. 141 (661)—*Valentine*.

the hock *d*. His fore-arm was very strong; neck-vein *e* full; and the brisket *h* not too deep, as is often the case with

Fig. 565.



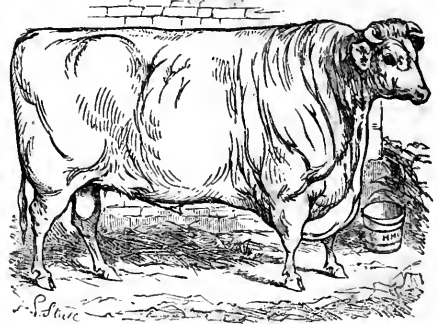
THE SHORT-HORN BULL.

bulls. The crest of his neck *a* was fine, and not lumpy, as is often seen on bulls. His hooks and back were remarkably straight and broad, measuring across the hook-bones at *b* 36 inches; the rump between *b* and *c* was full and round, and the tail-head *c* was particularly level and fine, showing no undue development of muscle on either side of the tail, as is often the case here—a deformity too generally admired, and in so far shows a prevalence of bad taste. His neck and shoulders were thickly sprinkled with curled locks of long hair, the entire body being covered with fine soft hair. The face was singularly ornamented with curled hair: it was shedded from a line down the front of the face, seeming as if it had been combed towards each eye; and the hair above the eyes seemed also combed up to meet the combed locks from the face. The roots of the horns were hidden with long locks of combed hair reaching to the forehead. His hide was loose, thick, and soft, and the touch mellow. He had a most robust constitution, never having had a single hour's illness in his life of 9 years. Unfortunately I had no measurement taken of his proportions, which I considered the most perfect of any bull I ever saw. He was kept generally in ordinary condition, getting in winter only a few turnips to serve for water, and principally supported on straw. In summer, his tendance on the cows was so constant, that he was very seldom seen grazing, although he never annoyed them even when in season. It was often amusing to observe the trouble he gave himself in looking after the wel-

fare of any of his own kind of stock that were in the same field with him. At length he was fed on turnips from November to April, when he was killed fat, and the butcher, Mr Johnston of Arbroath, informed me he weighed 139 stones, sinking the offals. I saw his flesh, which was really fine—much liker ox than bull beef.

6211. In fig. 566, I give an outline

Fig. 566.

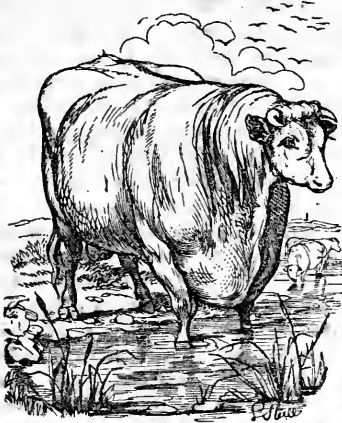


MR HOPPER'S SHORT-HORN BULL, BELVILLE.

portrait of a Short-horn bull that has obtained a most remarkable celebrity. It is that of *Belville*, a short-horn bull bred by John Mason Hopper, Esq., of Newham Grange, near Stockton-upon-Tees, Yorkshire. This remarkable bull carried the first prize of his class at the Show of the Agricultural Society of England at Wakefield, at that of the Agricultural Improvement Society of Ireland at Limerick, and at that of the Highland and Agricultural Society at Inverness, all in the year 1846, when five years old. And again, as a bull of any age, he gained a sweepstake of £70 of silver plate, at the Show of the Highland and Agricultural Society at Glasgow in 1850, against twenty competitors. He has, therefore, proved himself to be the best bull of his day. *Belville* was got by Newton, his dam by Gany-mede, by Uptaker, grand-dam Garland by Matchem. His head is remarkably fine for a bull, his neck small, and his extremities clean. His skin and handling are perfect, and so is the laying on of the flesh along all the upper part of his body, with no disposition anywhere to lay on lumpy fat. His back is uncommonly straight and broad from the hooks forward, and his chest remarkably wide and full, as may be observed in fig. 567, which

gives a fore-shortened view of his body. His quarter was long, and the space behind the shoulder well filled up. If any

Fig. 567.



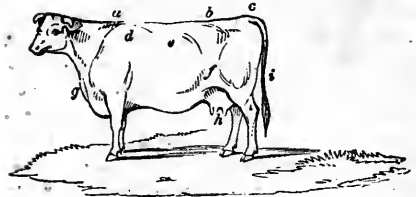
VIEW OF THE BACK AND CHEST OF BELVILLE.

point is exceeded, it is, I think, in the depth of the brisket, as may be observed in both figures. The piece of plate constituting the sweepstakes was a flagon, the lid of which was appropriately ornamented and surmounted by a model in silver of Mr Hopper's bull *Belville*, which had distinguished himself so conspicuously in beating in competition every bull brought against him at the national show held in each division of the kingdom: It was a happy coincidence, besides the elegant compliment, that the plate so ornamented should have fallen into Mr Hopper's own hands.

6212. Plate VI. contains the portraits of three Short-horn cows, belonging to his Grace the Duke of Buccleuch, at Dalkeith Park, Mid-Lothian. The one on the left hand was roan in colour, the centre one entirely red, and the right hand one entirely white, which are the three arrangements of colour presented by all Short-horns. The red and white are distinct colours in themselves, and the roan consists of a mixture of red and white hairs, being lighter and darker according as the white or red predominates. The principal cow in this group was the left-hand roan one, fig. 568, which was descended from the late Mr Robertson's, of Ladykirk, celebrated stock, and which was distributed over the country after the late Mr John Rennie of Phantassie got possession of it. Her name was *Kilmenny*: she

was got by Matchem, dam by a son of Mr Colling's George, grand-dam by Winyard. It will be observed that the grand-dam of

Fig. 568.



THE SHORT-HORN COW.

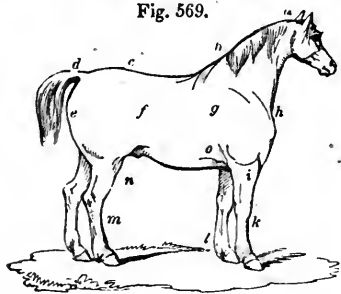
Mr Hopper's bull *Belville*, fig. 566, was also got by Matchem. *Kilmenny* was a cow of remarkably fine quality of skin, and her broad face indicated a good disposition to fatten. Her principal dimensions were from top of shoulder *a* to hook *b*, 3 feet; from hook *b* to tail-head *c*, $1\frac{1}{2}$ foot; extreme length from head to tail, 7 feet 3 inches; girth, 6 feet 5 inches; depth from hook *b* to flank *f*, 2 feet; breadth over the hooks *b*, 3 feet; from the ground to the fore-elbow, 2 feet 6 inches; from that elbow to the top of shoulder *a*, 2 feet; breadth across the shoulders at *a*, 2 feet 6 inches; the shoulders beautifully sloped from *d* to *g*; from nose to eye, 1 foot; length of ears, $7\frac{1}{2}$ inches; breadth of pelvis, 10 inches; the ribs *e* beautifully rounded; and the udder *h* finely formed and quartered. It will be seen from these numbers that she was long-bodied, from *g*, 5 feet 6 inches, in comparison to the depth, *b f*, 2 feet; and that she was broad behind, at the hooks *b*, 3 feet, in comparison to the breadth across the shoulders *a*, 2 feet 6 inches—the shoulders being, no doubt, thus sharpened by the great inclination of the scapula from *d* to *g*. The uncommon half-slouching, half-projecting position of her horns, and a sort of stare of her full eyes, gave her countenance a somewhat austere aspect uncommon in cows.

6213. As the colour of Short-horn cattle is a prominent characteristic of them, I may mention that roan is a handsome colour, and is, I believe, the general favourite now—the fancy for colour having gone from the red to the white, and is now settled on the roan. Dark red usually indicates hardness of constitution, richness of milk, and disposition to fatten; light red indicates a large quantity of thin milk,

and little disposition to fatten; but the red in either case is seldom entire, being generally relieved with white on some part of the sides and belly. White was considered indicative of delicacy of constitution; and to get quit of it, and at the same time avoid the dulness of red, the roan was encouraged, and now prevails. The white shows the symptoms sooner than any of the other colours of breeding in-and-in. A single *black* hair on the body, and particularly on the nose; or the slightest black or blue spot upon the flesh-coloured skin upon the nose, or around the eyes; or the least streak of *black* on the tips of the horns, at once proclaims that a Short-horn sporting either one or more of these impurities is of mixed blood—notwithstanding all attestation to the contrary.

6214. Applying the same points to horses, we shall take the gelding as the standard of comparison. Fig. 569 repre-

Fig. 569.



THE DRAUGHT-HORSE.

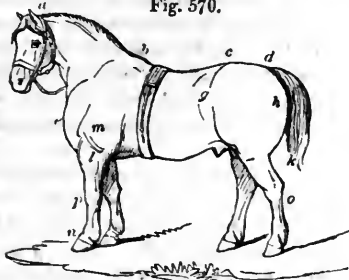
sents the grey gelding whose portrait is found in Plate XII. He was bred by the late Mr Curry when at Brandon, Northumberland, and was the property of Messrs. Howey and Co., the great carriers from Edinburgh into England. He was not a thorough-bred Clydesdale, having a dash of coaching blood in him, a species of farm-horse very much in use on the Borders, and admired for their action and spirit. This gelding exhibits such a form as to constitute, in my estimation, the very perfection of what a farm-horse should be. His head *a* is small, bone clean, eyes prominent, muzzle fine, and ears set upon the crown of the head. His neck rises with a fine crest from the trunk *b h* to *a*, and tapers to the head, which is beautifully set on the neck, and seems to be borne by it with ease. His limbs taper

gradually from the body, and are broad and flat, indicating strength; the knee *k* is straight, broad, and strong, and the fore-arm *l* broad and flat—all excellent points in the leg of a draught-horse, giving it strength and action. The back of the fore-leg, from the fetlock joint *l* to the body *o*, is straight, indicating no weakness in the limb—a failing here causing the knees to knuckle, and rendering the horse unsafe in going down-hill. The hind-legs *m*, as well as the fore ones *k* and *l*, stand directly under the body, forming firm supports under it. The body is beautifully symmetrical. The shoulder slopes backwards from *h* to *b*, the withers at *b* being high and thin. The sloped position of the shoulder affords a proper seat for the collar, and provides the muscles of the shoulder-blade *g* with a long lever to enable them to throw the fore-legs easily forward; and with such a shoulder a horse cannot stumble. The back, from *b* to *c*, is short, no longer than to give room for the saddle. The chest, from *b* to *o*, is deep, giving capacity for the lungs to play in, and room for the muscles required in draught. The top of the quarter from *c* to *d* is rounded, the flank, from *c* to *e*, deep, and the hind-quarter, from *f* to *e*, long. On looking on the entire side profile of the animal, the body seems made up of two large quarters, joined together by a short thick middle, suggesting the idea of strength and action; and the limbs, neck, and head, are so attached to the body as to appear light and graceful. In a well-formed horse, I may remark, that the line from the fetlock joint *l* to the elbow joint *o*, is equal to that from the joint *o* to the top of the withers *b*. In a low-shouldered leggy-horse, the line *l o* is much longer than the line *o b*; but in the case of this horse, the body *b o* is rather deeper than the leg *l o* is long, realising the desideratum in a farm-horse of a thick middle and short legs. The line across the ribs from *g* to *f*, is, like the back, short, and the ribs are round. He was 16 hands high, or 64 inches; measured from *a* to *b* 35 inches, from *b* to *c* 33 inches, from *c* to *d* 19 inches, being in extreme length 7 feet 3 inches. Length of the face 25 inches, breadth of face across the eyes 10 inches, length of ears $6\frac{1}{2}$ inches, breadth across the hook-bones 22 inches, girth behind the shoulder 80 inches, girth of fore-arm 23 inches, girth of bone below

the fore-knee $9\frac{1}{2}$ inches—the girth of this bone shows the comparative strength of the fore-leg of every horse—girth of neck at the onset of the head 32 inches, girth of muzzle 21 inches, width of counter 19 inches, and height of top of quarter *c* from the ground 63 inches. In a draught-horse the use of the collar causes the muscles upon the shoulder to enlarge, and the neck to become thin. This horse's name was *Farmer*, his walk was stately, and he could draw 3 tons on level ground, including the weight of the waggon. He was a well-known horse on the streets of Edinburgh for some years, and was generally admired. He was 11 years old when this portrait was taken, 1838; but whether he is now alive in 1850, I do not know.

6215. Fig. 570, and Plate IV., is the

Fig. 570.



THE DRAUGHT-STALLION.

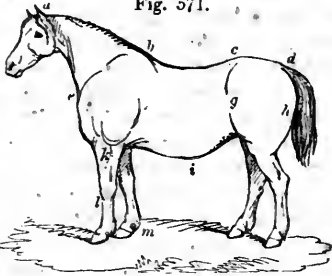
portrait of the black draught-stallion, *Champion*, bred by Mr James Steedman, Boghall, Mid-Lothian. He is of the true Clydesdale breed. He gained the first prize at the Highland and Agricultural Society's Show at Glasgow in October 1837, and obtained premiums elsewhere. He was a sure foal-getter. He was fully 17 hands high, 68 inches; and though otherwise a large animal, being 8 feet 7 inches in length, his action was high and uncommonly light. On comparing him generally with the gelding just described, though his body is longer, both hind and fore quarters are long and deep, exhibiting a large display of muscle. His middle is somewhat small, as is almost always the case with stallions which have served many mares, the frequent action of the muscles of the abdomen causing its contraction. Like all stallions, his neck rises beautifully from his body *b e*, in a full crest from *b* to *a*, evincing that castration and work have a powerful effect in

reducing the size of the muscles of the neck of geldings. The shoulder slopes well back from *e* to *b*, giving freedom of action to the fore-legs, while the muscle at *m*, being fully developed, assists in imparting strength to that action. The hind-quarter, from *g* to *h*, is long and deep. The fore-leg is straight, and short from knee to fetlock, *p* to *n*, the bone under the knee strong, and the fore-arm *l* flat and broad. On comparison, the fore-legs of the gelding are fully more handsome. The hind-legs *o* are remarkably so. The sweep of line from the crown of the head *a* along the back to the tail-head *d* is truly elegant; giving a very fine top to the quarter. The fulness of the hair in the tail *d k* indicates great strength of back. His eye was good, though somewhat small, and the ratch of white down his face marred the beauty of his countenance; and both the hind legs being white was also against his general appearance. His disposition was remarkably docile, and his whole demeanour harmless. His constitution was good, and he was an excellent traveller. These are a few of his dimensions:—from the crown of the head *a* to the top of shoulder *b* 51 inches, from the top of the shoulder *b* to the top of the rump *c* 30 inches, from the top of the rump *c* to the tail-head *d* 22 inches; in all, 8 feet 7 inches. Length of face $26\frac{1}{2}$ inches, breadth of face across the eyes 11 inches, length of ears $6\frac{1}{2}$ inches, breadth across the hook-bones 30 inches, girth behind the shoulder 90 inches, girth of fore-arm *l* 28 inches, girth of bone below the fore-knee 12 inches, height of the top of the quarter *c* from the ground 67 inches, girth of neck at the onset of the head 39 inches, girth of muzzle 24 inches, and width of counter 22 inches. He was a gay, lively, beautiful horse when run out, and his action was apparently very easy to himself.

6216. Fig. 571, and Plate VIII. is the portrait of a brown Clydesdale draught-mare, belonging to the late Mr George Bagrie, Monkton near Dalkeith. Mid-Lothian. She gained the first premium at every show of stock she was ever exhibited. The white ratch down her face, and so much white on her legs, detract from the beauty of her appearance; but notwithstanding these drawbacks, she

is an exceedingly handsome and beautiful mare. You have only to look at the plate to observe the easy flowing lines of her whole

Fig. 571.



THE DRAUGHT-MARE.

contour, and also the great substance of both fore and hind quarter. The rise and crest of her neck from *b* to *a*, and from *c* to *a*, are remarkably fine. The back from *b* to *c* is somewhat hollow, and there is a corresponding depression of the belly at *i*, both being the effects of foal-bearing; as there is, besides, a slackness of the flank in front of *g*, a usual deficiency in brood-mares. The top of the rump from *c* to *d* is very fine. The shoulder slopes well from *e* to *b*, indicating good action; the muscles are well developed on the fore-quarter from *e* to *f*, indicating power in draught; the ribs are round, and the barrel long from *f* to *g*, a favourable configuration in a brood-mare for giving room for the growth of the fœtus. The hind-quarter from *g* to *h* is long. The legs are placed directly under the body, the fore-knee *l* being broad and strong, the back of the fore-leg from the fetlock *m* to the body straight, and the fore-arm *k* broad and flat. I have no measurement of the dimensions of this mare, for a comparison with those of the gelding and stallion. Beside roundness and length of rib, a brood-mare should be wide across the hook-bones and the pelvis, to afford room for the growth and subsequent egress of the foal. This mare gave up foal-bearing at an early age.

6217. I have chosen a *black* stallion, *brown* mare, and *grey* gelding, to illustrate the three colours most commonly seen amongst farm-horses. A *black* stallion seems the favourite colour, and a *brown* mare is not uncommon, but a *grey* draught horse is much more uncommon now than it was 20 years ago. It is said that the feet of *grey* horses are more tender than

those of horses of other colours; and also that the white feet of horses of other colours are more tender than dark-coloured feet; but on what grounds I cannot say.

6218. In Plate IX. is a representation of a *dinmont* *Leicester* sheep. The perfect form of the breed would have been best shown in a wether, but a *Leicester* wether is now-a-days so very seldom to be found that I could not obtain one for a portrait to be taken. Nor will the *dinmont* in the plate be of much use as a reference, since its posture in reposing on the ground is unfavourable to affording a proper view of its form. The head and a leg, however, indicate that the sheep was well bred, and the texture of the wool is well preserved. Like the ox and the gelding, in cattle and horses, the wether best exhibits the points of a particular breed, which the breeder should cultivate with a view to profit, and free from those sexual characteristics which the stallion and the mare, the bull and the cow, and the tup and the ewe, must always possess.

6219. Plate XIII. contains the portrait of a *Leicester* *tup* which belonged to the Duke of Buccleuch; as also another without the fleece in fig. 330. The *tup* in the plate exhibits the peculiar properties of the breed to which he belongs; the principal of which are, face and legs covered with white hair, a hornless head, and body well enveloped in long wool. The individual characteristics of this *tup* are, rectangular carcase, round rib, small bone, fine head, small muzzle, large full eye, and expressive countenance, and his ears much shorter than usual. The head of the *tup* is broader across the eyes than that of the ewe or wether, and the skin becomes a little wrinkled upon the nose when he gets aged. The wool is thick-set, long, of good quality, and the fleece envelops the entire body above and below, — a mark of sound constitution, and a great means of preserving the animal from the bad effects of the weather above, and of the dampness of the ground below. A level broad back from neck to rump, and across the ribs, is characteristic of the *Leicester*; and on being turned up, a broad chest with fulness of flesh in the arm-pits and the inside of the hams. The touch should be equally mellow along the back,

a hardness in any part indicating a defect. In ordinary condition, the flesh above the tail-head is nicked, which may be easily felt with the points of the fingers; but when in high condition, which they should be at the tupping-time in autumn. (4721.) the nicking should extend all the way from the shoulder-top to the tail. The rib should also be well covered with flesh and fat. The bones of the legs should be strong; broad and flat, and the limbs placed immediately under the carcass to support it. The physical strength of a Leicester tup is great; having large muscles concentrated within small bounds, he can exert a strength forward which no man's strength is able to counteract, as long as the tup's feet remain upon the ground; and consequently the only, and at the same time the most ready means, within the reach of a shepherd, to prevent him going away, is to seize one of the hind legs from behind, when locomotion is instantly arrested.

6220. Plate VII. contains a portrait of a Leicester ewe and its lambs, and fig. 572

Fig. 572.



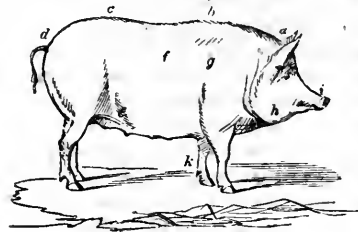
THE LEICESTER EWE AND LAMB.

is a representation of them. She also belonged to the Duke of Buccleuch, at Dalkeith Park, Mid-Lothian. The points of the Leicester ewe are, head generally long, narrow, and clean, with fine muzzle, prominent eyes, and long, broad, thin ears. The bone of the leg is small, fine, broad and flat. In this particular instance, the body is well-woolled and rectangularly formed. The counter *g* is full; the shoulder well filled up behind at *a*; the rib at *f* round and full; and the loin at *e* filled up, not hollow, as is sometimes the case, particularly after ewes have borne a number of lambs. The wool comes forward full behind the ears on the top of the neck at *i*, thus keeping these organs protected; it is also full towards the cheeks at *h*,

which keeps the throat warm; the belly is well covered with wool at *b*, as also the flank at *c*; the rump *d* is level with the back, and carries the levelness to the tail-head, from which the tail drops perpendicularly, and there is abundance of wool to protect the anal and vaginal passages from the cold. Some ewes are high in the rump, while others are rounded down to the tail-head, somewhat in the form of the pig. Gimmers generally carry a large proportion of wool upon the rump, which afterwards bared down to the level of the back wool. It is quite a common occurrence in a flock of Leicester ewes to bear a large proportion of twin lambs, and even to wean them to the extent of 50 per cent beyond their own number. Many ewes bear twins every year, whilst others have only single lambs.

6221. In Plate V. is the portrait of a sow which belonged to the Duke of Buccleuch, at Dalkeith Park, Mid-Lothian, and fig. 573 represents the same animal.

Fig. 573.



THE BROOD SOW.

Here the same rule applies as to symmetry and disposition to fatten as in the cases of the ox and the sheep. The head *a* is small, the face tapering to the snout *i*, which is short and fine; the ears are set on the crown of the head, being broad, thin, long, and so mobile as to indicate quickness of perception. The value of the head, as an article of food, is indicated by the enlargement of the muscle upon the cheek *h*. The neck from *a* to *b* is full; the back from *b* to *c*, broad; the rump from *c* to *d* full and round, and the roundness descends to the hams; the ribs *f* are round; the space behind the shoulder at *g* filled up; and so is the flank *e*; the shanks *k* are small and short, and finely tapered. A pig with these properties is always in a condition for use, from the state of a pig sucking milk, through its progress of porking and shott, till it attain the full size for

bacon and hams. Such a breed never requires feeding, and as it is always in condition, it requires only time to grow to the size wanted, when a little firming of the flesh by corn soon prepares it for slaughter. The shott should have been instanced as the state of the pig class, which shows the points of most value for profit; but the difference in the points of the sow and shott are so little defined, that the representation of the one serves well enough for that of the other.

6222. When a boar attains the age of several years, the tusks are seen to project a considerable way beyond the lip; and if he is at all cross in temper, and is permitted to go about the courts of the steading in which the cattle are confined, and to make his litter in them, he has been known to injure the cattle—which may have trampled upon him accidentally in the litter—so very seriously with the tusks, as to occasion even death. He strikes upwards with the tusks; and should the stroke be directed to the belly of the ox, the skin and the peritoneum will be instantly torn, and the bowels laid bare, the strength of the neck of a large boar being almost incredible. I have observed, however, that the boar is more friendly with cattle than with horses, and especially young ones, which often delight in giving him a bite or a kick in passing. With large tusks, it is safest either to break off their points, or prevent boars making their litter amongst cattle and horses.

6223. Plate XIV. gives portraits of the different kinds of poultry reared on a farm, without regard to fancy breeds. The black Norfolk breed of turkeys I have heard recommended as being both strong and large; and I have seen a pure white variety; but I should not desire a better breed than the light grey, whatever their name or origin may be. The young cocks attained, with me, every year at least 15 lb. each by Christmas. The old cocks never became troublesome, which I have seen the black variety do; and the hens are most careful mothers and great layers. The Dorking is decidedly an excellent fowl, and I perceive that the grey variety is preferred to the white—at least they are much more frequently to be seen. Nevertheless the common Ham-

burgs should never be lost sight of, they being now entirely inured to this climate; and they are generally very healthy and good layers, their flesh possessing, if not great delicacy of whiteness, a good flavour. I think it would be worth while, as a matter of profit, for farmers to make and rear capons for the market, being soon fit for the table: the process of caponing might be easily learnt. There has not yet been introduced any bird of the goose tribe better than the old grey goose and white gander. I have tried a cross with the Chinese gander and the common goose, as also one with the common gander and the Chinese goose; but though the progeny was larger than either, and became rather handsome birds, the flesh was coarse and the flavour spoiled. Aylesbury ducks are certainly superior to the common ducks both in size and flesh; and they are not only large layers, but lay all winter.

6224. Fig. 574 is an outline portrait of

Fig. 574.



THE COMMON FOWL.

the common hen in the plate. The flesh of a fowl is chiefly found on the sternum or breast-bone, which, when not full, the fowl is considered lean. The development of the muscle there is dependent on the state of the extremities. When the head and limbs are large and coarse, the skeleton of the body, including the breast-bone, are long and narrow, and then the muscle is thin and sinewy; but when they are small and fine, the horn of the bill firm, the scales of the legs thin and close set, and the eye large and clear, the body assumes a roundness of form, becoming deeper and approaching to the oval.

When of this form, the muscles become thicker, larger, and tenderer. Fat does not seem deposited in the muscle of the fowl, but the cellular tissue between the fibres of the muscles become enlarged. The fat is mostly seen on the rump and the sides; it increases in the inside; it lines the body-under the skin, through which it is easily seen. It is a characteristic of all the domesticated fowls to have a round plump form of body in connection with fine extremities; and these points are certainly indicative of a disposition to fatten.

ACCOUNT OF SOME OTHER BREEDS OF
CATTLE AND SHEEP.

6225. *Long-Horns*.—The Long-horns are a breed not confined to England, being also found in Ireland; but there are none, to my knowledge, in Scotland. This breed was brought to great perfection by the celebrated Bakewell, in Leicestershire, and on that account were first called Leicesters. After the success attending the breeding of the Short-horns—so named from their horns being short—by the brothers Collings, the Long-horns lost part of their reputation; and the merit of the Collings as breeders was the more remarkable, in that they had to cope with so formidable a rival and celebrated a breeder as Robert Bakewell; but fortunately for them, and for the country also, they had a better subject to begin with. After the establishment of the Short-horns, the Leicesters were called Long-horns, their horns being frequently very long; as also to distinguish their name from Bakewell's improved breed of sheep, which were often named Leicesters, from the county where they originated, at Dishley, the residence of Mr Bakewell. Fig. 575 re-

Fig. 575.



THE HEAD OF A LONG-HORN BULL.

presents the head of a Long-horn bull, which belonged to Mr R. Horton, Sherborne, in Warwickshire, and was exhibited, and obtained the first prize of his class, at the Show of the Royal Agricultural Society of England at Oxford, in July 1839, when he was 4 years 2 months old. It will be observed that the face is short and broad, muzzle small, the eye large and expressive, the horns fine, tapering, and sharp-pointed, and the countenance agreeable. His colour was light brown, brindled with black stripes. The skin was thin and mellow, and the hair mossy. The skin of the nose and around the eyes dark flesh-colour. The slouching position of the horns is very common in the Long-horn breed; they are brown, with a few reddish streaks, and tipped with brownish black. His dam and grand-dam were also bred by Mr Horton, and his sire was bred by Mr Court, near Warwick. He was regarded as a very superior animal of his kind. His weight was estimated at 100 stones. I give a few of his principal dimensions. From crown of the head to the top of the shoulder, 36 inches; from top of shoulder to a line with the hooks, 36 inches; from line of hooks to tail-head, 22 inches; total length, 94 inches; length of face, 21 inches; from eye to nose, 13 inches; length of ear, 6 inches; breadth of face at the eyes, 10 inches; girth of neck at the onset to the head, 46 inches; girth of muzzle, 22 inches; girth behind the shoulder, 96 inches; breadth across the hooks, 24 inches; breadth across the shoulders, 24 inches; height from ground to fore elbow, 27½ inches; height from elbow to top of shoulder, 27 inches—together, 54½ inches; height from ground to top of hooks, 56 inches, so he stood 1½ higher before than behind; depth from hook to bottom of flank, 27 inches; from the ground to the hind hock, 20 inches; breadth of brisket, 6 inches; length of horn, 27 inches; girth, 9 inches.

6226. *Herefords*.—The Herefords take the name from the county in which they originated. They are a fine race of cattle for steers, and in symmetry the steers are very similar to those of the Short-horns. At one time much rivalry existed between those breeds as feeders, and profitable for beef, and at first it was rather in favour of the Herefords, as mentioned by Mr Knight;

but according to the later statements of the Rev. Mr Berry, the Short-horns had established their superiority as feeders. There never was a doubt of the Short-horn cow being a much better and a much longer milker than the Hereford cow. For my part, I never had the good fortune to see either a Hereford bull or a Hereford heifer as handsome as many Short-horn bulls and heifers I have seen. Fig. 576 represents the head of a Hereford ox

Fig. 576.



THE HEAD OF A HEREFORD OX.

which belonged to Mr S. Druce, Ensham, near Oxford, and was exhibited at the Show of the Agricultural Society of England, in July 1839, where it gained the first prize of its class, when it was 4 years 4 months old. It will at once be observed that the muzzle is fine, the eye large, full, and lively, and the horns small, tapering, and sharp-pointed. A bright-white face is very common in the Hereford breed, which gives them a clean appearance, with white horns having brownish-red points. The body is either dark or light-red and white, a common colour, or a dark rich chestnut-brown, which is becoming fashionable. The handling was firm and mellow. Hide not thin. Hair soft and pleasant to the feel. The skin on the nose and around the eyes was fine flesh-colour. The countenance not very placid. The walk stately. It was bred by Mr Arthur Thomas James, Mornington, near Hereford. The dimensions of its principal points were these: From crown of head to top of shoulder, 29 inches; from top of shoulder to the line of hooks, 37 inches; from line of hooks to tail-head, 19 inches; total length, 85 inches; length of face, 23 inches; from the eye to the point of the nose, 12 inches; breadth of face across the

eyes, 10 inches; length of ear, 6 inches, smooth outside, hairy inside; length of horn, 24 inches; girth, $10\frac{1}{2}$ inches; girth of muzzle, 19 inches; girth behind the shoulder, 100 inches; breadth across the hook lines, 29 inches; breadth across the shoulders, 28 inches; height from the ground to the fore elbow, $30\frac{1}{2}$ inches; from the elbow to the top of shoulder, 27 inches—together, $57\frac{1}{2}$ inches; from the ground to back at the hooks, 57 inches, so that he stood level; from hooks to bottom of the flank, 28 inches; from the ground to the hind hock, 21 inches; breadth of brisket, $14\frac{1}{2}$ inches. It weighed 76 stones.

6227. *West-Highlanders, or Kyloes.*

—The West-Highland oxen have long been famed in Scotland as superior to any for yielding prime beef. They have all the fine points of the Short-horns in the body, which is covered with an abundance of shaggy soft hair, that bids defiance to the keenest blasts and the most drenching rains. Fig. 577 gives an idea of the head

Fig. 577.



THE HEAD OF A WEST-HIGHLAND OX.

of an ox which belonged to the late Mr Campbell of Jura, and was shown with another as good as itself, as a pair, at the Highland and Agricultural Society's Show at Inverness, in October 1839, when they gained the first prize of their class. It will be observed that the muzzle is fine, eye large and full, and the horns long, small, tapering, very sharp-pointed, white, and tipped with black. The colour of the body is usually black, sometimes red, and not unfrequently dun. The black coloured,

I understand, makes the most profitable animal to the feeder. The skin on the nose, and around the eyes, is always black. The ears are very distinctly set on the head, and are well protected with long hair, and these, with the large tufts of long hair over the roots of the horns, give a very picturesque effect to the head, quite suited to the taste of the artist. The walk of the Kyloc is steady and determined. His countenance firm, and not over placid. The cows, when suckling their young, are very jealous of any one approaching them. The bull is generally long-bodied and short-legged.

6228. *Angus*.—The black doddies of Angus obtain their name from the county they inhabit. They have earned fame in the London market as samples of good beef. To Mr Hugh Watson of Keillor, in that county, this breed is most certainly indebted for the firm establishment of the largest share of that fame; for I am persuaded that, had it not been for Mr Watson's great exertions in improving their points, by which the degree of perfection the breed is capable of arriving at has been shown, their fame would not have been so great, nor would an improved race have been so generally distributed throughout the country. The fame of the breed, however, in Mr Watson's hands, is only a repetition in Scotland of what had been done in England for the Short-horns and Leicester sheep by Collings and Bakewell. His merit is equal to theirs, though following at a later period of time, inasmuch as he was the first person in Scotland who raised any of its domesticated breeds from a low to a very high position. Fig. 578 represents the head of an Angus ox, 4 years old, bred by Mr Watson, and exhibited by him, with another as a pair, at the Show of the Highland and Agricultural Society at Dundee in 1843; and it obtained the first prize of its class at the Show of the Agricultural Improvement Society of Ireland in that year. It obtained no premium at Dundee, in consequence of its companion not being equal to itself, Lord Panmure exhibiting a more equal pair. It will be observed that its muzzle is fine; eye prominent and lively; ears broad, thin, and well fringed with hair. Its head is destitute of horns, which is

characteristic of the breed, and earns for it the appellation of the *doddies*, or hornless cattle; and, for the loss of this

Fig. 578.



THE HEAD OF AN ANGUS OX.

weapon of defence, it is furnished with a hard enlargement of bone upon the crown of the head, which is always surmounted with a tuft of long hair. Its countenance was placid. The skin was not too thin, the handling mellow, and the hair thick set in and soft, though not long. It had the characteristic of the purity of its breed, not a hair to be found upon it but what was black. It was the most perfect ox of its kind I ever saw; I could not find a fault in it, though I have tried to do it. On this account, I am proud in having in my possession a faithful portrait of it in oil, taken from the life at Keillor, shortly after it was exhibited at Dundee, by Mr Gourlay Steell of Edinburgh. A rather remarkable history attaches itself to this ox. It was purchased from Mr Watson for His Royal Highness Prince Albert, who exhibited it at the Smithfield Club Show in 1843, and from thence it returned to Windsor Park, Her Majesty not permitting it to be sold to the butcher. It is still there; and, in order that it may enjoy a long life, which good health alone can insure, it is gently worked for exercise every day in a large roller upon grass.

6229. *Ayrshires*.—The Ayrshire breed originated in the county from which they

take their name. It is chiefly for their milking properties that this breed has been so sedulously cultivated; and it is in such high repute on that account, that most of the dairies of the nobility throughout the kingdom are furnished with Ayrshire cows. I have myself sent heifers even to America for that purpose. In this respect the breed presents a remarkable contrast to the Herefords, which are chiefly brought up as steers; whereas the bull calves of the Ayrshires are generally fed as veal, and only some heifers brought up to renew the stock of cows. The most common colour of the Ayrshire cattle is red and white: sometimes an entire red one is to be seen; but never a white one, the two colours being dispersed in patches. Sometimes a yellow colour makes its appearance, and even a dun, which may give rise to suspicions as to purity of blood; but such colours are known to be borne by stocks of the purest and oldest blood. The points considered good in an Ayrshire bull, by the breeders of that species of stock, are a broad short head, the horns spreading from the side a little in front, and turning upwards. The top of the shoulder sharp, back rather narrow, and rounded over the ribs, ribs rather flat, hooks confined, hams thin, tail-head somewhat drooping, belly enlarged, and legs very short. These are all points opposed to those of a good Short-horn; and the points in which they agree are a straight back, loose mellow skin, large eye, sharp muzzle, and small horn. Fig. 579 represents an

Fig. 579.



THE AYRSHIRE BULL.

outline portrait of the best Ayrshire Bull I ever saw. He was bred by Mr

William Brodie, Lochwinnoch, Ayrshire, and was exhibited and gained the first prize of his class at the Show of the Highland and Agricultural Society at Glasgow in August 1844, when 4 years old, by Mr Robert Paton, Cloverhill, Dumbartonshire, from whom I purchased him for the late Mr Cranston of Corehouse near Lanark. This bull was a remarkably fine handler, had a fine head and very clean limbs. His back was a little hollow. In all other respects he agreed much with the description given above of the breed generally. The cows are best liked for a very sharp shoulder, and wide hooks and pelvis, in which conformation the ribs are always flat and the belly large. The udder is desired to be hemispherical, situated forward, and provided with loose soft skin behind. All these points of the bull and the cow are aimed at by breeders, on the supposition that they tend to promote the greater secretion of milk; but such a view is based on doubtful grounds. The present tendency of the breeders of Ayrshire cattle, in Ayrshire, is even to go beyond the points enumerated above, and to add light weight to them—a delicate appearance and a well-set milk vessel being the points most aimed at. Attempts have been made for some years past to cross the Alderney with the Ayrshire, in both ways, putting the Alderney bull to the Ayrshire cow, and the Ayrshire bull to the Alderney cow; but the endeavours to imitate the form of the Alderney cow have not succeeded, and the result has rather tended to produce in both progenies the inferior points of both breeds, as might have been expected; for the Alderney bull has not so good a frame as the Ayrshire cow, nor has the Alderney cow so good a constitution as the Ayrshire bull. The light weights have been attained by the reprehensible practice in all breeding—by starving the young heifers, with the avowed object of making them good milkers, whereas its direct tendency is to injure the constitution of the milking stock. On the contrary, were the heifers bred and reared so as to attain heavier weights and greater substance, they would not only prove better milkers, but afterwards feed to greater weights. The paramount object of the Ayrshire breeders, for profit, ought obviously to be to obtain the largest quantity of milk, with the greatest disposition to fatten

when put up to be fed; and assuredly neither of these ends will be attained by light weights and delicacy of appearance.

6230. *Cheviot*.—Fig. 580 represents Fig. 580.



THE HEAD OF A CHEVIOT TUP

the head of a Cheviot tup which gained the first prize of his class at the Highland and Agricultural Society's Show at Aberdeen in 1840, and was exhibited by Messrs Craig, Bighouse, Sutherlandshire. It will be observed that the face is longer than that of the Leicester, muzzle not so fine, eye not so full, ears not set so high and handsomely upon the top of the head, and there is a rugosity of the skin across the bridge of the nose. In the white face, and want of horns, the Cheviot resembles the Leicester. The wool is short, thick-set, and of fine quality, fit for the sorts of manufacture as that of the Southdowns. The carcass is usually unequal, the fore-quarter being lighter than the hind—narrow in the chest, with the fore-knees set near. The flesh is fine-grained, often well intermixed with fat, and is generally esteemed for the table. The disposition of the Cheviot is somewhat suspicious, with an inclination to rove; which renders the breed rather unsteady and unkindly to feed, at least at an early age. The Cheviot, as their name implies, had their origin in the Cheviot Hills, in Northumberland. They occupy almost all the pastoral hills of the south of Scotland, especially from the centre of the country to the eastward. They are localised in some of the best parts of the Grampian mountains, and are to be found as far north as the hills of Caithness and Sutherland. They may, therefore, be regarded as a

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hardy race, and well suited, on that account, for the middle green pastures of the mountainous parts of our country. In Plate IX. is a portrait of a Cheviot wether, in which the lightness of the fore-quarter is well shown, as well as the sharp look of the eye which the breed exhibits, and which gives a somewhat wild aspect to the countenance. The back is straight, and the figure pretty rectangular. The letter P on the near rump, buisted on with tar, (4018,) is the initial of the name of the farm where it was bred, or that of the farmer who bred it.

6231. *Black-faced*.—Fig. 581 represents Fig. 581.



THE HEAD OF A BLACK-FACED RAM.

sents the head of a Black-faced tup which was exhibited by Mr Robert M'Turk of Hasting's Hall, Dumfriesshire, at the Highland and Agricultural Society's Show at Berwick-upon-Tweed in 1841, where it obtained the first prize of its class. As indicative of the judgment and care with which the breed has been cultivated, we have only to look at the tapering face, small muzzle, and full eye. The Black-faced ram has always an arched nose, expressive of boldness and courage. The face and legs are covered with black hair, or mottled with white, mostly the latter. The head is horned; and the horns, being large and curved in the aged tup, are considered the most picturesque objects of their kind exhibited by any animal of this

2 z

country. The wool is somewhat long and coarse, which render it of comparatively small value as an article of manufacture, and, being rather thin-set, exposes the body to the inclemency of the weather. To assist the animal to withstand the weather, the fleece is subjected to the filthy operation of smearing, which deteriorates its value considerably. The carcass is well formed, carrying its depth forward to the brisket better than the Cheviot; but still the entire body is narrow, owing to the flatness of the ribs, which renders it light—or in want of *substance*, as it is commonly called. The flesh is fine-grained, high-flavoured, greatly esteemed, and can be fed sufficiently fat on the turnips and pastures of the low country. The breed is very hardy, frequenting the highest parts of our heath-clad mountains, and in summer require little care from the shepherd. Fig. 582 represents the head of a young

Fig. 582.



THE HEAD OF A BLACK-FACED EWE.

Black-faced ewe, whose muzzle and face are small, with a full, prominent, bright eye. The horn is short, because the ewe is still young, but it is handsomely set upon the head. The hair of the face is somewhat mottled, which is the more common colour in the ewe than the pure black. The colour of the lamb's face, however, is most frequently entirely black, and becomes mottled as it advances in age. The wool comes well round the face, and the ear is protected with thick-set hairs. In Plate IX. is a portrait of a Black-faced wether, which gives a good representation of that age and condition of this valuable breed of sheep. The eye is prominent and bright. The muzzle small. The wool plenty, and well brought about the face. The legs are

strong, and set directly below the body. The back is straight, and the form of the side is rectangular. The great defect of the Black-faced breed is the narrowness of back, which much reduces the weight of the carcass. Could its back be made a little broader, the chest would become wider, and then the animal would feed easier and quicker, and afford greater profit.

6232. *Scottish Original*.—More as a curiosity than a matter of interest, I give in fig. 583 a representation of the head of

Fig. 583.



THE HEAD OF A TUP OF THE ORIGINAL BREED OF SCOTLAND.

a tup of the original breed of sheep of Scotland. Very few of these now remain. A small lot was exhibited at the Show of the Highland and Agricultural Society at Inverness in 1839, where I saw them. They were small, keen, active-looking creatures. The face was tawny, the eye lively, and not unpleasant in aspect. The horn yellowish brown, and curved in the form of the Black-faced. The muzzle small. The wool was not unlike that of the Black-faced, but rather more hairy. The legs are of the colour of the face, whether white or tawny. The head, face, and horns of the breed have a strong resemblance to those of the Black-faced breed, and may have been the foundation upon which it was reared; but with what cross the face became black does not appear, although a late writer remarks that a black-faced sort from England was said to have originated that of Scotland.*

* *Quarterly Review*, March 1849, p. 406.

6233. *Southdowns*.—Only a few years since, the Southdown sheep were little known in Scotland; but what was then known was favourable to their character, and they now are deservedly becoming more and more a favourite. Like the Cheviot, they are covered with short, thick-set, fine wool, but it is of a dusky brown colour, which is also the colour of the hair that covers the face and legs. They are hornless. In symmetry of body they are much superior to the Cheviot, having their quarters, like the Leicester, about equal. Their flesh is fine-grained, and, as high-flavoured mutton, is preferred to that of the Cheviot in the London market. They have also a gentler disposition, and are in consequence better feeders. The only doubt with the Southdowns, on their introduction into Scotland, was their ability to withstand the damp climate of our sub-alpine pastures. The experience of several years has proved that they are capable of enduring any climate with the Cheviot; which being the case, with their other superior qualities, they bid fair to rival, and perhaps ultimately to displace, that breed. Mr Hugh Watson has had them at Keillor, in Forfarshire, for more than 20 years, and they have thriven with him upon the pastures of the Sidlaw Hills. The Duke of Richmond also has them in Morayshire. Other flocks are now scattered through the country.

6234. Fig. 584 represents the head of a
Fig. 584.



THE HEAD OF A SOUTHDOWN TUP.
Southdown tup, which belonged to Mr

Jonas Webb, Brabraham, Cambridgeshire, and was exhibited by him at the Show of the Highland and Agricultural Society at Dundee in 1843, where he obtained the first prize of his class. From this figure it appears that the face of the Southdown tup is short and broad, the eye large and lively, the muzzle somewhat thick, and the nose slightly arched; the ears are widely set on the head, and are rather thick and short. The wool in this particular sheep does not come on to the crown of the head, but I have seen Southdowns with a tuft of wool upon it. I should say, from its general appearance and thick-set wool, that this breed has a strong and hardy constitution.

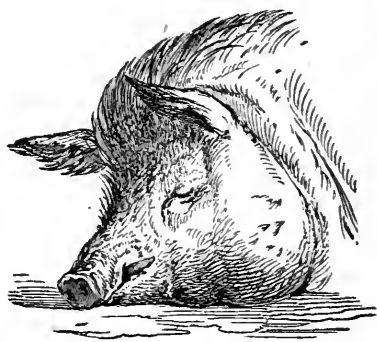
6235. *Swine*.—The breeds of pigs are generally divided into the small and the large, though they are not sufficiently marked in character to exhibit the specific differences between them in their purity. In breeding either of those breeds of pigs, it is of essential importance to keep them pure, for otherwise they will degenerate into coarseness, the one losing its earliness of maturity for making the best pork, and the other its valuable qualities for curing into ham and flitches of bacon. For the use of the farm the large breeds are best adapted for the market, if intended for curing, and the small for porklings, or for the ordinary consumption of the house—which should always be highbred, as they will then be in such condition as to be ready for use at all times. Perhaps the best pig for the poor labouring man is a cross between the large and small breeds, and to carry it no farther. The breeding of pigs deserves great care, much more so than is generally bestowed upon it; and in them it is difficult to attain the right standard of merit; but in the attainment of that point, the pig assumes a corresponding value in the market and at home. I had a small breed of pigs of the greatest value. I received a young boar and sow as a present from Lord Pannure, of a breed called the Western, because it was reared by the late Lord Western, in Essex, with great success. They were brownish black and white, something like the colour of the wild boar. Their head was short and broad, snout short and fine, eye small and lively, ears prick-shaped, set upon the crown of the

head. The cheeks large and full. Legs short and small boned. The body full and round. The skin smooth, without a wrinkle, thin, and pretty well covered with hairs and long bristles. They were always in condition, though they got leave to go about in search for the greatest part of their food in the green fields and courts. As long as the sows and young pigs were confined, they were well attended to with litter, water, and food. When kept on, they would attain a great weight, but I never kept them beyond 20 stones, and only those which were intended for curing into hams for the house. They were the most docile creatures imaginable, hardly moving out of your way on the road. They were very healthy, and the young ones when cut soon recovered. Their flesh was well mixed with fat, and the fat was more like tender gristle than soft lard. I have not met with a superior breed anywhere.

6236. The slouch-eared breed that prevailed in the country is fast being supplanted by the pricked-eared breeds, because, wherever the slouch-eared is found, it is universally accompanied with length of leg, length of nose, narrowness of back, and dilatoriness in feeding. I believe the prick-ears, short snouts, and full cheeks, may be traced to an improvement derived from the Chinese breed, which possess those points even to deformity. Their crosses with the old bony breeds have been the means of disseminating through the country several races of beautiful, profitable, delicate-fleshed pigs.

6237. Fig. 585 represents the head of

Fig. 585.



THE HEAD OF A BOAR.

a boar of the large breed which belonged to the Duke of Buccleuch, at Dalkeith Park, Mid-Lothian. To judge by the sleeping head, the boar, though evidently full-grown and large, bears the same characters of pricked ear, tapering face, short nose, and full cheeks, with the full flesh of the neck of the small breed. These pigs have strong constitutions, and are covered with plenty of white hair and valuable bristle. Their temper is generally docile, and they seldom wander far from the stading, or engage in mischievous pursuits. The position of the tusk is marked by the opening in the upper lip.

6238. *Horns.*—Much may be observed in the set and form of the horns as indicative of the character of their bearers. Small, short, slouching horns on a two or three-year-old ox give a grave and contented cast to the countenance, as may be observed in the portrait of the Short-horn ox in Plate X. Long slouching horns, as on many of the Long-horn oxen, seem to oppress the head with a constant depression. Horns springing outward from the sides of the head, then rising up, and bending backwards, never fail to impress one with the conviction that their bearer is quick tempered, ready to use them offensively on most occasions; and they are set so as to toss up any object with ease, as may often be exemplified in the West-Highland cow. Horns curving laterally and horizontally forward give a finished appearance to the top of the head, when viewed in front, as exemplified in the figure of the centre Short-horn cow in Plate VI. Long horns rising outward, forward, and having points looking outwards, impart a very majestic air to the head of the ox, as shown in fig. 577 of the West-Highland ox. Horns rising outward, and then approaching behind the head, give an idea of malformation. Horns springing outwards, and then coming straight forward in the points, seem formidable. Horns springing outwards, and then approaching forwards, with the points a little elevated and separated, as in the Hereford ox, when seen in front, seem to ornament the head, but at the same time to oppress it with weight. A horn thick at the root for its length looks clumsy, and so does one blunted at the point; and both are associated with dull feeders. When springing outwards much, and then turning downwards, as in the left-hand Short-horn cow in Plate VI., they seem ungraceful. A good horn, however set, is small where it emerges from the head, and tapers gradually to a fine point. A white horn looks cleaner than a dark-coloured one, and a tip of brown or black, according to the breed, gives a pretty finish—though most Short-horns have theirs entirely white, and, being short and curving inwards, serve more for ornament than defence. Oxen with spreading horns are better feeders than those which contract suddenly towards the front. Horns indicate the age of cattle. At three years of age, the horn is uniformly smooth from the root to the tip.

Every year after three, it is protruded from the head with a notch on it ; so that, by counting the number of notches, and adding three to this number, the age of the animal may be ascertained. Tricks are practised by fraudulent dealers, in filing down some of the oldest notches, to make the animal appear younger than it is, and the unwary are thereby deceived ; but a slight inspection of the horn will easily detect the fraud. The period of calving, whether late or early, naturally affects the notches of the horn, and may give an older or younger appearance to the animal than its true age. A hornless ox seems as if it had been deprived of the means of defence; the size of the head in the bull making up for the loss to him ; but a hornless heifer assumes the gentle appearance of her sex.

6239. As with cattle, the horns of sheep indicate the age of the animal. In fig. 581, the age of the Black-faced tup is distinctly marked, the 1st year's growth being evidently the space from the point of the horn to the letter *a*, when the horn is small ; the 2d year is from *a* to the notch at *b*, the growth of the horn of the dimont being stronger and longer than that of the hogg ; the 3d year's growth is marked from *b* to the notch at *c*, which is still longer and thicker in growth ; the 4th year, from *c* to the notch at *d*, shows the vigorous state and great length which the horn of the animal had attained at that age ; and this is no doubt the most vigorous period of the life of a sheep ; and the 5th year's growth is shown from *d* to the root *e*. The age of the ewe, fig. 582, is young, not exceeding two years. That of the wether in Plate IX. is greater, not less probably than four years, though the marks are not specified with the distinctness necessary to decide the age with certainty.

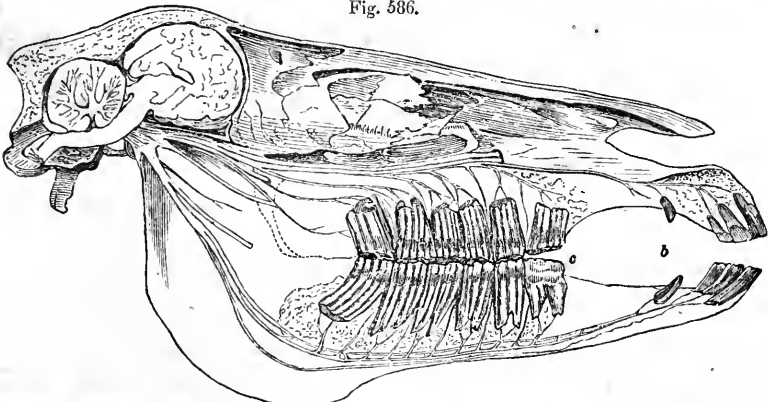
6240. Horns are very sensitive organs, no

part of the body indicating the presence of internal disease more quickly than they do. Although in pushing directly forward with them in the fight horns will bear a great force, yet a single stroke upon them with a cudgel is severely felt by the animal, and a single such stroke has been known to cause them to slip off their flint, which is a vascular bone, full of blood-vessels, so that inflammation of the brain or lock-jaw may ensue. The horn indicates the internal state of the animal, because its root is very thin, and, being close upon so vascular a part as the flint, the state of the blood is more easily ascertained than at any other part. When the horn feels cold, death-like cold, we may suspect congestion of the blood in the smaller blood-vessels somewhere, in consequence of inflammation.

6241. *Teeth.*—The teeth are more important organs to the domesticated animals than the horns. The horns are the mere instruments of defence and of attack ; and the nurtured state in which the animals are usually placed renders their use unnecessary ; but the teeth are the instruments by means of which they break and masticate their food in winter, and crop and masticate the grass in summer ; which being the case, the condition of the animal mainly depends upon the state of soundness in which their teeth may be preserved. One common property exists between the horns and teeth of animals—both furnish data by which their age may be ascertained. You have already seen how the horns are indicative of the age, both of cattle and sheep, and we shall now advert to the manner in which the teeth may be examined for the same purpose.

6242. Fig. 586 represents the left half of the head of an adult horse, viewed internally, and so figured as to show the origin of the 5th pair of

Fig. 586.



THE VERTICAL SECTION OF THE HEAD OF THE ADULT HORSE, SHOWING THE TEETH AND THE NERVOUS SYSTEM IN CONNECTION WITH THEM.

nerves, and the nervous branches which go to the teeth ; on which account the figure may be consulted with equal advantage for a knowledge of the distribution of the nervous system and of the teeth. The milk-teeth of the horse consist of 12

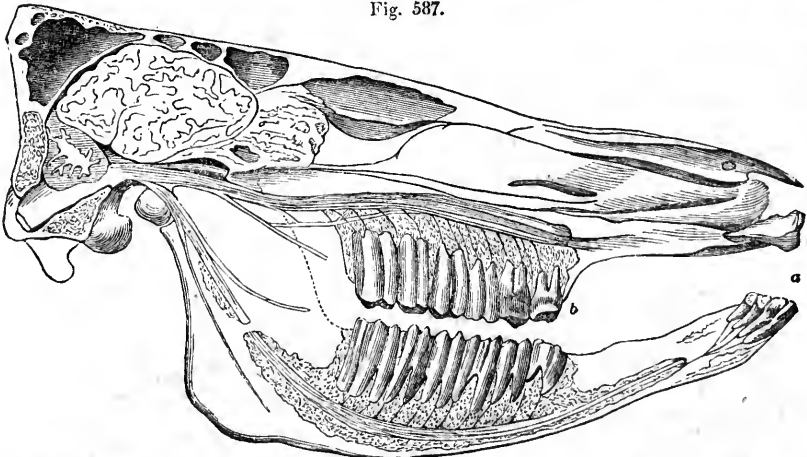
incisors, 6 in each side of the head ; and of molars 16 in number, 8 on either side of the head—in all 28 teeth. The teeth of the second dentition are 40 in number, of which 28 have replaced the milk-teeth. Those between the

incisors and molars, called the canine or tusks, do not appear along with the teeth at an early age. Others complete the arch by occupying the room made by the growth of the jaws; these are new molars which come out of both jaws. The full set consists of 12 incisors, 4 canines, and 24 molars—in all 40 in number. In fig. 586, *a* are the incisors, *b* the canine or tusks, and *c* the molars. "This is the order of coming out of the second or permanent dentition of the horse," observes M. Rousseau. "The first permanent molar, which is situated behind the last milk-molar, presents itself before any of the milk-teeth have fallen, and makes its appearance upon the maxillary arch from the 11th to the 13th month after birth; it will be, by numerical number, the 4th persistent molar, when all the milk-molars have fallen. The 5th permanent molar, which is situate behind the preceding tooth, breaks the edge of the socket from the 14th to the 20th month. During this time the decaying teeth die from their roots, and wear down their crowns to such a degree, that the hollow which characterises the surface of the incisors at certain periods cannot be observed, so that the veterinarians call them lost-mark. The central incisor or pincer is ordinarily of the 9th or 11th month; the lesser incisor from the 11th to the 13th

month; and the lateral incisor, or corner-tooth, from the 14th to the 20th month. Once these teeth cease to have mark, they bear upon their surface a smooth trace, brown and indelible, which diminishes the more the teeth approach their fall. The first permanent molar replaces the 1st and 2d milk-molar from 2 years to 2½ years. The central incisor appears upon the edge of the socket after the coming out of the 5th permanent molar, from 2½ to 3 years. The 2d permanent molar replaces the 3d milk-molar a little after the same term, or one or two months of difference. The 3d permanent molar replaces the 4th decaying molar at three years; at this time also appears the 6th and last molar. The lesser incisor from 3½ to 4 years. The canine or tusks appear from 4 to 4½ years. At last, the second dentition is ordinarily terminated by the lateral incisor or corner-tooth. It must not be thought, however, that the coming out, as I have endeavoured to indicate as the most ordinary, is without variation; this would be to give to nature too regular a progress. All teeth in general are the more developed that they belong to a large and robust subject."

6243. Fig. 587 gives a similar representation of the dental system of the *adult ox*, and of the

Fig. 587.



THE VERTICAL SECTION OF THE HEAD OF THE ADULT OX, SHOWING THE TEETH AND THE NERVOUS SYSTEM IN CONNECTION WITH THEM.

nervous system connected with it, that the preceding figure gives of those of the horse. The milk-teeth of the ox are, 8 incisors on the lower jaw, and none on the upper, and 12 molars, 3 on each jaw. In the adult ox are 8 incisors on the lower jaw, and none on the upper; and there are 24 molars, 6 on each jaw. In the figure, *a* are the incisors, and *b* the molars, and the same configuration exists in the sheep. "In the second dentition, these teeth show themselves upon the edge of the socket in the following order," says M. Rousseau. "The 4th permanent molar comes out from the 4th to the 6th month after birth, and commences the second dentition. The 1st or central replacing incisor, from the

15th to the 22d month. The 5th, or penult molar, from the 18th to the 22d month. The 2d replacing molar, as also the 2d incisor of this order, appear from the 28th to the 32d month. The 3d replacing molar, as also the 3d incisor, come out very near at the same time, that is, from the 38th to the 48th month. The 6th, or last molar, from the 44th to the 52d month. At length the 4th permanent incisor tooth terminates the second dentition, which is ordinarily completed when the animal has not yet attained its 5th year."

6244. Fig. 588 gives a section of the head of a *wild boar*, in which the dental and nervous sys-

tems are distinctly delineated: *a* are the superior incisors; *b* the superior lateral incisor; *c* the inferior incisors; *d* the upper canine or defence

tusk; *e* the inferior canine or defence tusk, the origin and form of which may be easily traced; and *f* are the molars. I have selected the head

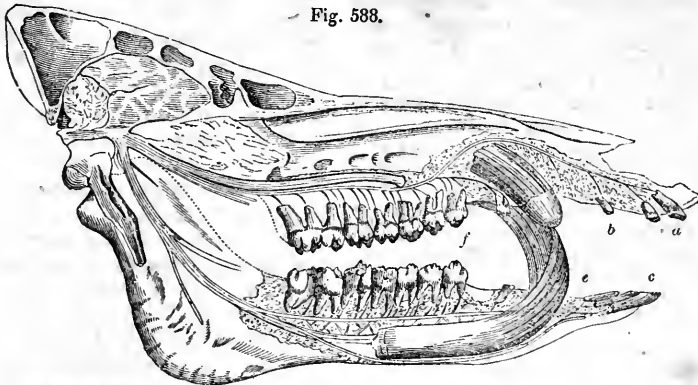


Fig. 588.

THE VERTICAL SECTION OF THE HEAD OF THE WILD BOAR, SHOWING THE TEETH AND THE NERVOUS SYSTEM IN CONNECTION WITH THEM.

of the wild boar for illustration, because the character of all the teeth, and particularly that of the tusks, is more strongly developed than in the domesticated boar. The tusks of the sow are comparatively short and weak. The milk-teeth of the ordinary pig are 32 in number, namely, 12 incisors, 4 canines or tusks, and 16 molars, half of which numbers are on each side of the head. The second dentition is only completed as soon as all the milk-teeth have fallen; and these are not only replaced, but 3 other molars on each jaw rise up, one after the other, until the whole dental arch is completed, when the entire complement is 44 teeth, of which 22 are on the upper, and 22 on the lower jaws, and they are divided thus,—12 incisors, 4 tusks, and 28 molars. These teeth are composed of two substances, the one bony, the other enamelled. "The tusks are each enclosed in a socket, filled with a substance analogous to the marrow of the long bones; it is most remarkable, and most abundant in the inferior tusks. These teeth are only provided with enamel upon the external face of the permanent tusks." *

6245. In regard to the indications of age by means of the teeth, in the horse the marks on the crowns of the front teeth on the lower jaw are almost always obliterated, or at least cannot be depended on, after 9 years of age. After that period, the only means of judging is by the quantity of matter ground off the top of the teeth, and by the distance between the teeth themselves; the older the horse gets, the wider the space between them becomes. In regard to the grinding down of the teeth, however, you should know that pasturage on sharp land, and support on hard food, such as unbruised corn and beans, will wear down teeth much faster than pasturage on soft land and prepared food. The same remark applies to cows which have been pastured on sharp or soft land, and been

fed on straw and turnips, or on boiled food—and it is only applicable to them; for as to steers, their age, being very limited, cannot be mistaken from the growth and condition of the body. The teeth of cows also stand wider as they advance in years.

6246. A horse's mouth is easily opened for the purpose of examination, by introducing a finger by the side of the mouth into the space between the incisor and molar teeth, where the bit of the bridle lies upon the tongue, when the horse will play his mouth, to get quit of the finger, and show as much of the lower teeth as to ascertain what you want. Some sulky horses require to have their lips held asunder; and vicious ones will even strike out with the fore-feet when their mouth is meddled with. I had a work-mare which, the moment her mouth was attempted to be held for examination, would wheel quickly round, and kick with the hind feet at the person attempting it. A cow's mouth cannot be examined, without first holding her nose, elevating her mouth, and drawing down her under lip. Some cows will not allow themselves to be taken by the nose, and the thing can only be done, in such a case, by stratagem. Some, again, have such a power in their nose in curling up the nostrils when held, that its pressure against the holder's fingers renders them soon powerless; but a steady pinch of the thumb-nail against the septum of the nose will make any cow give way, provided the person has strength to hold her firmly at her first attempt to break away.

6247. *Malformation.*—Any malformation in the reproductive organs of breeding animals may incur a serious loss to breeders. A draught stallion, which gained the first prize of his class at a Show of the Eastern Forfarshire Agricultural Association, left no produce in the district he had served for the premium. It was afterwards discovered

* Rousseau's *Anatomie Comparée du Système Dentaire*, p. 205-30.

that one of his testes had never descended into the scrotum. A very fine Short-horn bull, which gained the premium at the Show of the Border Union Agricultural Society at Coldstream, could not get one of the cows he had served in calf. It was ascertained that the testes had never descended freely into the scrotum. A Leicester dinnott tup, that I knew had been engaged for the season by a breeder, did not get a single ewe in lamb from a similar malformation. In all these cases, the loss and disappointment to a large number of breeders was of the most serious description, being deprived of the increase of a large proportion of their year's stock. Of other kinds of malformation, I have seen an ox have an orifice, a sort of vaginal opening, between his buttocks, by which he emitted urine instead of by the ordinary urethra. He seemed to feel no inconvenience, and thrived and fattened well enough.

6248. The origin of the domesticated animals has given rise to much difference of opinion among writers, one class averring that they must have been produced by the care of man from the wild races nearest akin to them, whilst others maintain that they were originally created for man's use. Those who believe that they have been derived from the wild races, argue that man's condition was originally savage; whilst those who believe that they were created for man's use, also believe that man was originally created a civilised being. This question was well discussed by the late Mr Stark of Edinburgh, who adduced abundance of proof that, if man had been created a savage, he would have continued a savage to this day; and that no type of the domesticated animals are to be seen in a wild state, except those whose history are known. The semi-wild horses and cattle met with on the steppes of Tartary have increased in numbers, from a few domesticated ones which had gone from man's control; and it is well known that the horse and the ox were unknown in America until after its discovery by Europeans. A decided proof that the semi-wild races of horses, oxen, and dogs were once domesticated is to be deduced from the fact that, when captured, they at once submit to man's control, whereas no really wild race of any animals has yet done so; and consequently man has domesticated none. The same sort of evidence Mr Stark adduces in regard to the cereal grains which support the human species, none of which have ever been found growing in a wild state. I entirely agree with Mr Stark's views on these subjects, and believe that the original state of our present domesticated animals was domestication. Such a view is also most consonant with what is stated in the sacred volume.*

ON THE PRINCIPLES OF BREEDING.

6249. The great principle upon which the breeders of stock proceed, in breeding

all the kinds of the domesticated animals, is, that "like produces like;" and this law of resemblance is so universally applicable to all sorts of breeding, that, were the proper means always taken to produce it, the result would never end in failure. No doubt, means have always been supposed to have been taken to attain that end, and many breeders have actually used them for that purpose; and the results they have produced have been excellent, and have in fact been the source from which has been derived all the improved breeds of our domesticated animals. Still it must be owned that the procedure has been founded on no higher a principle than that, because a dam or a sire was seen to possess one or more desired points, it was proper to employ her or him, or both, for the attainment of those points in their progeny. The points desired might be attained, or they might not; for all breeders proceeding in this way must acknowledge having been disappointed beyond their expectations, whilst others have obtained success beyond the means used would warrant. In either case the procedure was empirical, and faith could only be placed in the means employed, in proportion as a similar result had been produced in the experience of the breeder himself.

6250. Now, it would be extremely desirable could less be left to chance, and more to certainty in breeding—that is, less to empiricism and more to principle, than has hitherto been the case, even although success has hitherto attended the many attempts made in the dark; so that he who could point out a more certain way upon principle, would not only lessen the toil and enhance the profit of the farmer, but also earn the gratitude of the country. I think such a person is found in Mr Alexander Walker, an eminent physiologist in London, who has explained his views on this subject in distinct language, in a work which he published. Mr Walker takes man in illustration of his views, because he is the most perfect being in existence; and he divides the several organs and functions of his structural system into three great classes—the *locomotive*, the *vital*, and the *mental*.

* *Transactions of the Royal Society of Edinburgh*, vol. xv. p. 177-210.

6251. The locomotive organs consist of the organs of support, as the bones; the organs of connection, as the ligaments; and the organs of motion, as the muscles. That those organs may perform their functions, it is necessary that they be connected with the motor nerves, which arise from the cerebel—the portion of the brain situated in the back part of the head; and they are also connected with the movable part of the face, the under lip, and the jaw. The shape, the limbs, the skin belong to this class.

6252. The vital organs consist of the organs of absorption, as the lymphatics; the organs of circulation, as the arteries, veins; and the organs of secretion, as the glands. That those organs may perform their functions, they are connected with the sympathetic nerves, which arise from the cerebrum, the portion of the brain occupying the fore part of the head; and they are also connected with the immovable parts of the face, as the forehead, and above the lowest part of the nose. The digestive, respiratory, and reproductive organs, together with fat, milk, and other animal products, belong to this class. The beautiful flow of the lines of the body, the manner, the action, the health, the constitution are dependent on these organs and their functions.

6253. The mental organs consist of the organs of sense, as the eye, ear; the organs of perception, as the cerebrum; and the organs of volition, as the cerebel. The functions of the organs of sense are to receive impressions from external bodies by means of the eye, ear, smell, and touch; the functions of the cerebrum are to perceive, compare, reflect; and those of the cerebel to will, and consequently to throw the muscles into action to fulfil its purpose. The cerebrum is in connection with the organs of sense which receive the impressions by the senses, convey them to those of perception—the cerebrum—which in its turn acts upon the organs of volition or will, which sets the locomotive organs in motion.

6254. A mere knowledge of those organs and their functions would avail nothing, were it not in our power to distinguish whether or not one parent, or both indiscriminately, impart their organisation to their offspring. It is the want of this distinction which has caused the breeding of the domesticated animals to be conducted in the uncertain manner I have alluded to. Mr Walker clearly expounds that one class of organs are propagated by one of the parents, and the other class by the other parent, and that either parent does not propagate either class indiscriminately; and moreover that, in the propagation of organs from parents to progeny, organisation is nearly indestructible, for it may often be seen that neither nourishment entirely derived from the mother, nor climate, nor education, diminishes an original likeness of the father; and, without this effect, it would not be possible for like to produce like. Each parent, therefore, communicates a distinct series of organs; and the only modifications which the organs communicated by either parent undergo, are chiefly, if not altogether, such as are necessary to harmony

of action with those communicated by the other parent, and to difference of sex.

6255. The one parent communicates the anterior part of the head, the upper middle part, the osseous or bony part of the face, the forms of the organs of sense, (the ear, upper lip, lowest part of the nose,) and the whole of the nutritive system, (the contents of the trunk, or the thoracic and abdominal viscera, and consequently the form of the trunk itself, in so far as it depends upon its contents.) The resemblance to that parent is consequently found in the forehead and the bony parts of the face, as the orbits, cheek-bones, jaws, chin and teeth, as well as the shape of the organs of sense, and the tone of the voice. These constitute the vital system.

6256. The other parent communicates the posterior part of the head, the lower middle part, the cerebel situate within the skull immediately above its junction with the back of the neck, and the whole of the locomotive system, (the bones, ligaments, and muscles, or fleshy parts.) The resemblance to that parent is consequently found in the backhead, a few more movable parts of the face, as the ear, the under lip, eyebrows, and the external form of the body, in so far as they depend on the muscles, as well as the form of the limbs, even to the fingers, toes, nails, &c. Several circumstances indicate that with this series of organs go the skin and its appendages, which have much affinity with the osseous system. Not only does the skin become horny from pressure, but hair, wool, bristles, spines, scales, nails, bones are its productions, (the bony and skinny often uniting in horns;) and in many inferior animals, as the crustaceae, it becomes shelly, and serves the purpose of bones. These constitute the locomotive system.

6257. As regards the human race, Mr Walker observes that the male or the female parent may give either series of organs; that is, either forehead and organs of sense, with the vital and nutritive organs, or the backhead, with the locomotive organs.

6258. Amongst the domesticated animals, the effects of those laws have been observed to have taken place, but the laws themselves on which those effects depend have in no case been defined before Mr Walker did so. Observation has proved that the male animal has a stronger influence over the organisation of the progeny than the female, and that he communicates the locomotive organs to the progeny, and consequently that the female communicates the nutritive organs. Keeping this distinction in view, it is evident that any changes desired in any particular organ of the domesticated animals will be more easily and certainly effected than those in the human organisation. The late Mr Knight, the eminent physiologist, had observed that among domesticated animals he had never witnessed any difference in the influence of the male or the female parent upon the forms of the heads of the offspring. The obvious reason given by Mr Walker for this is

that in cattle, horses, and sheep, the form of the back-head and cerebel is hid by the great transverse ridge of the occipital bone, to which the large muscles which raise the head are attached; as also by those muscles themselves, and by the elastic ligament, which, without voluntary effort, assists them in maintaining the position of the neck. In man, on the contrary, owing to his upright position, the head is greatly supported by resting on the vertebral column; large ligaments and muscles are not required, and the projection caused by the back-head and cerebel is perfectly obvious. Horses, cattle, and sheep, therefore, show only the forehead and face; and their whole head consequently seems to go, undivided, along with the vital organs in the trunk of the body. Concealed, however, though the back-head is in these animals, we have proof of its various developments in the various developments of the muscular system, with which the former must always correspond, and which at all events show what each parent communicates.

6259. With regard to the mental organs, it is evident that in all voluntary acts in which two sexes are engaged, two thinking systems are involved; and as the first portion of the thinking system, sensation and observation, is passive or dependent on impression, and the last portion, dependent on passion and volition, is active and exciting to locomotion, it is evident that, in the act of reproduction, one or the other sex will always be relatively passive, and the other relatively active. Hence the progeny will receive from the one parent the organisation in which, in the thinking system, sensation and observation depend, and from the other that in which passion and volition spring; for the very term reproduction implies the communication of similar organs and functions, and therefore of the most energetic and characteristic ones. Thus the communication of mind, and of its most distinguishing or peculiar characteristics, to progeny, evidently depends upon mind, and the relative predominance of its two great divisions in the parents; and on each of these again depend the locomotive system and the vital respectively. The entire law may thus be briefly stated in regard to the breeding of the domesticated animals:—The thinking organs are, in equal and distinct portions, derived from both parents; while the dam gives the whole of the nutritive, and the sire the whole of the locomotive organs.*

ON THE SELECTION OF PARENTS IN BREEDING.

6260. Since males communicate their organisation with the most obvious effect, they are in most request amongst breeders for the improvement of their stocks. High prices have been given, and high premiums are annually offered, for superior males,

whether stallions, bulls, or tups; and it is fortunate for the more rapid extension of the improvement of stock, that the influence of the male thus bears sway in the propagation of his kind, as by the permission of polygamy one male may serve many females, and thereby extend his influence in the exact proportion to the number of the latter; whereas a female produces usually one in the course of a year. A stallion serves from 60 to 80 mares, a bull 60 cows, and a tup 60 ewes in a season—not once or twice only, but as often until the female prove with young. Generally the female conceives at the first service of the male, and at all events at the second; but should her desire continue beyond that time, she is withdrawn from breeding, to avoid the risk of a late progeny, or none at all; for a late calf, lamb, or foal loses one year of its progress, compared with its earlier born companions.

6261. Few farmers commit the mistake of not selecting the best male that can be produced; but many commit the inconsistent mistake of employing inferior females. In horses, for example, the prize horse of the district will generally be selected to serve the mares, but it is rare to find the best mare in the farm bearing foals. The brood mare, or there may be more than one, is generally one which is too old to keep up in the work with the rest of the horses, and although her back be swung with work, her wind broken, and she have a bad leg, she is considered quite suitable for bearing foals. The very opposite system ought to be followed: the best mare should carry the foals bred on the farm; and a strong, fresh mare with a good constitution will be quite able to take her share of the work, and bring up a foal besides. Let mares not be under 5 years of age when the horse is first put to them; for they will not have acquired their full stature until that age; and from that period let them bear a foal every year until they attain 12 or 13 years, when they should cease to breed; as *old* mares, any more than old females of other classes of animals, cannot produce a vigorous progeny. Thus, for 7 years, may fresh young mares, stunted to the best stallions that can be secured, produce, and bring up, foals every year.

* Walker *On Intermarriage*, p. 147 to 173.

Such foals will be strong in bone and constitution, and be always in high condition, because they are the offspring of young mares themselves high in condition, and overflowing with milk; and, having been brought up together, will work better together. I recommend this plan with confidence, because I have myself followed it with success for years. I do not remember selling a young horse, warranted to work well on a farm, under £35, when horses were low in price; and I had three excellent mares when I employed four pairs of horses, and two out of the three bare foals every year.

6262. In regard to cows the practice is better than that with mares, although it is not so good as it should be, many heifers being transferred to the cow-stock that ought never to have become the inmate of a cow-byre. Another mistake is, that when a cow happens to be a good milker, she is kept for breeding long after her constitution has become weakened by age, and the demand is kept up upon her system in bringing up a calf every year, and of supplying milk after the calf has been weaned. A young healthy cow will be much more profitable than any old worn-out favourite.

6263. Ewes are also better selected for breeding from than mares, though too many are kept in the flock because they may have happened to cast an extraordinary fleece of wool, or two lambs every year, or have always brought up their lambs well. The same rule, however, applies to them as to cows—old age brings along with it many infirmities in them. And it ought never to be forgotten that such infirmities, although not originally existing in the females, and only brought on by hard labour, or by long use, will yet be communicated to the progeny as certainly as if they had originally existed in the parents.

6264. I think I may safely say, that if you select stallions and mares, bulls and cows, tups and ewes, boars and sows, of such animals as their portraits in the plates to this work indicate them to have been, you will not commit a great mistake.

6265. Following out Mr Walker's law of the part which each parent performs in the production of the progeny in its application to the selection of parents, we can at once see that, if we want any organisation belonging to the locomotive system, we shall look in vain for it to the female; and, on the other hand, if we want any organisation connected with the nutritive system, we shall seek for it as much in vain in the male. Every amendment, therefore, desired in any of the kinds of our stock, we must first ascertain to which of the systems of organs it belongs, and employ a male or female to amend it, as the case may be. Thus diseases of the digestive or respiratory organs in a female would be far more fatal to the welfare of the progeny than if the same complaint were observable in the male, and the female were entirely free from them; but then it should never be lost sight of that both the parents should have all their natural and respective powers in absolute perfection, otherwise we run the risk of inviting the propagation of disease. We may also expect that whatever increases the ardour of passion invigorates the progeny. It is moreover observed, that habits and pursuits long followed develop the organs they employ. Thus, a draught stallion and mare will produce foals whose muscular system is as well suited for labour in the plough as the cart. A racing stallion and mare will likewise produce foals well adapted for speed. A cow, whose disposition to fatten is great, will produce calves with that tendency; and a bull, which displays much spirit and resolution, will likely produce calves of similar tendency, if there be in all these cases no counteracting function exercised by the other parent. We may say, then, that the hereditary powers will generally be found best calculated to do that which the parents through successive generations have done. Mr Knight remarked that, when the male and female parents are of the same variety, each parent has an equal influence on the offspring as to temper, sagacity, &c., and in giving hereditary propensities; that is, both parents equally originate the mental organisation.

6266. In breeding horses subject to the laws enunciated, it is necessary that the organisation of the animals selected should be of the most perfect kind—a certain age, and the exercise and perfection of every function, are essential. A horse should be perfectly mature before covering. A mare may breed at four year old; at an earlier period breeding will interfere with the development of her structure and strength. A stallion constantly exercised has superior progeny to one kept in a state of inactivity. A horse or mare incapable of work, or which has suffered from hard and continual labour, is certainly injurious to its progeny. Constitutional infirmity is fatal. A mare that has slinked her foal is always liable to the same conduct.*

6267. The practical properties of a good draught stallion are these:—Sound constitution, good temper, easy action, short legs, straight back, round rib, strong over the loins, deep chest, good

* Walker *On Inter-marriage*, p. 173 and 330.

ends, lengthy quarter, and plenty of bone and muscle. Such properties in a horse cannot fail to improve his kind.

6268. The properties of a good draught mare are these:—Mares, too, instead of possessing imperfections, hereditary diseases, and bad forms, and being either worn out or too young, ought to have short legs, broad deep chest, back rather long than too short, a broad well-lifted and round loin, quarters long and rounded on the top, haunches wider than the hips, fine animated head, pleasing countenance, density and firmness of muscle, sinew, and structure, clean muscular and sinewy leg, large knee, broad wide hock, the shank and sinews in both fore and hind legs well developed, and straight dropped below the hock-joint. Such a mare cannot fail to throw a good foal when served with such a horse as has just been described; and when both sire and dam are well assorted, their progeny will most probably possess their distinctive characters.

6269. Under the same laws Mr Walker thus describes the characteristics of the best cattle:—Face rather short, the muzzle small, the horns fine, the neck light, particularly where it joins the head, the chest wide, deep, and capacious, the tail broad and fat towards the top, but thin towards the lower part, which it will always be when the animal is small-boned, the lower part of the thigh small, the legs short, straight, clean, and fine-boned, though not so fine as to indicate delicacy of constitution, the flesh rich and mellow to the feel, the skin of a rich and silky appearance, the countenance calm and placid, denoting the evenness of temper essential to quiet feeding and a disposition to get fat. If to these we add a straight back, round rib, and deep flank, the description is what we would give of a good ox, which is the standard of acquired excellences. Any addition necessary to the above would arise from sexual differences merely, such as a deep brisket and erect neck to the bull, and wide and capacious pelvis to the cow. Other properties conformable to the same law are, that the tendency to fatten is indicated chiefly by the capacity of the chest, though the habits of ancestry will operate generally very powerfully. It is the width and depth of frame which confer weight, and not the mere circumstance of height. While equally great, if not greater, weights can be obtained with shorter-legged animals, they are, independently of other recommendations, generally found to possess a better constitution, and a greater propensity to fatten.

6270. Some years ago the desire of breeders was to produce a disposition to fatten at earlier ages than had been the custom for many years before; and in pursuing this object others were partially lost sight of, even the size and shape, and the milking property almost entirely so. It was perhaps well, however, for the present race of cattle that the effort to fatten early was made, for while that disposition is now settled by hereditary descent, it is in the power of the breeder to fatten to any degree he chooses, while he can dispose of his cattle in a state of moderate fat-

ness, and in much flesh, to suit the altered taste of the market. The taste now for more flesh than fat is favourable for the development of the milking property; and as both fattening and the production of milk appear to require a good vital or nutritive system, which transmits and transmutes the animal liquids, both properties may be possessed by the same animal with undoubted compatibility; for while the fleshy state will produce the more milk, as long as the cow is giving milk, when the period arrives that she should no longer do so, she can be easily fattened for the market: but cows, as well as women, wanting that system in a good state will be destitute of both fat and milk. Large udders are not necessarily indicative of great milking powers, for much fatty substance may be interposed between the glandular masses which secrete the milk; and a comparatively smaller udder, wholly composed of palpable glandular masses, will give much more milk than a larger one which is chiefly made up of fat. Climate would seem to have an effect on both the fattening and milking properties of animals. Cold diminishes sensibility, and it is by the interposition of fat between the skin and the central parts of the body by which the sensibility is lowered. Hence, in the north, animals easily assume the fattened condition. Heat, on the other hand, excites sensibility, and it is found that cows afford more milk in the warmer than the colder counties; and it is there, also, that they are always thinner in condition. Hence, from these principles, one animal fattening in the north would become a better milker in the south, where more genial temperature would render fat less necessary, would increase sensibility, and cherish the secretion of milk, so intimately connected with that excitement of the reproductive functions which warmer climates produce.

6271. It is with sheep as with cattle in this system, that the fattening property is connected with the vital or nutritive functions; but the wool belonging to the osseous is rather in connection with the locomotive system. In the selection of sheep, therefore, we should look to the tup for the wool, and to the ewe for the disposition to fatten. A tup, therefore, that has a good fleece, and a ewe that is broad-chested, and a good handler, should be put together, provided always that both possess their respective functions in a healthy state. Large heads, long necks and legs, are inconsistent with excellence in those systems. Climate has a material effect upon the wool. In very warm countries wool is not only converted into hair, but scantily covers the body. Cold, on the other hand, renders wool finer and thicker on the body, and crisp. While in a temperate region, on the plains, and in a humid atmosphere, the wool is long, not coarse, and very heavy. These different effects of climate may be easily explained. A thin covering is required in a warm country to allow freedom to a copious perspiration to keep the body cool. In a cold country, where sheep have to wander far and near on the mountains for food, fat is prevented from being deposited, as it would be the case were it not, for the opposing cause; and the skin, thereby

becoming more sensitive, requires a closer and warmer covering to protect it. In the plains the rich food causes a luxuriant growth of the wool, while the rain is best thrown off by a long staple. It is the nature of the climate, and the quality of the food, that renders our country the proper sphere for the production of long wools; and having this natural advantage over other countries, we need fear no carelessness in our farmers causing deterioration in the fleece of our Leicester and other long-woolled sheep. The co-existence of fat and wool in the same animal is quite compatible, since they originate in different systems, and are produced by a different parent. The finer the long wool any sheep produces, the more easily fattened will it be. Wool is as capable of being improved by proper selection in breeding as any other property. Sheep require to be mature, of full stature, in good health, have perfect organs, and be in entire possession of all their faculties, when the male is put to the female for breeding, (4715).*

6272. Liebig has explained in an apparently satisfactory manner the very remarkable connection that exists between the formation of fat and the respiratory process, which physiologically expressed requires the broad chest of the animal. "There is but one way in which the formation of fat in the animal body is possible, and this is absolutely the same in which its formation in plants takes place: it is a separation of oxygen from the elements of the food. The carbon which we find deposited in the seeds and fruits of vegetables, in the form of oil and fat, was previously a constituent of the atmosphere, and was absorbed by the plant as carbonic acid. Its conversion into fat was accomplished under the influence of light, by the vital force of the vegetable; and the greater part of the oxygen of carbonic acid was returned to the atmosphere as oxygen gas. In contradistinction to the phenomena of vitality in plants, we know that the animal system absorbs oxygen from the atmosphere, and that the oxygen is again given out in combination with carbon or hydrogen; we know, that in the formation of carbonic acid and water, the heat necessary to sustain the constant temperature of the body is produced, and that a process of oxidation is the only source of animal heat. Every pound of carbon which obtains the oxygen necessary to convert it into carbonic acid from substances which thereby pass into fat, must disengage as much heat as would raise the temperature of 200 lbs. of water by 70°—that is, from 32° to 102°. Whether fat be formed by the decomposition of fibrin and albumen, the chief constituents of blood, or by that of starch, sugar, or gum, this decomposition must be accompanied by the separation of oxygen from the elements of these compounds. But this oxygen is not given out in a free state, because it meets in the organism with substances possessing the property of entering into combination with it. In fact, it is given out in the same form as that which is absorbed from the atmosphere by the skin and the lungs."[†]

ON BREEDING IN-AND-IN.

6273. No wonder, when high-breeding produces such an improvement in stock as to render the head small, fine, and beautiful, the extremities elegant, the form handsome, and the disposition so accommodating as that the animals grow and fatten without feeling disturbed at what passes around—in short, become so prepossessing as to make their owners mistrust those of others—that they are employed to increase their own numbers. It was this feeling which actuated Bakewell to breed only from his own stock, after he had brought the Leicester sheep and Longhorn cattle to perfection. For a time the late Mr Mason of Chilton pursued the same course; and there are breeders in England at the present time who maintain that it is the best system, and will follow no other. Perhaps a stock brought to the highest state of perfection, and at the same time possessed of sound constitution, may be supported free of deterioration for many years by the peculiar skill of its owner; and I can conceive it possible for a high-bred stock, such as Bakewell's was during his whole lifetime, to be increased and maintained in its purity by the assistance of kinship. One valid reason must have induced Mr Bakewell to employ only his own stock—that no other so good as his own existed to select from; and it would have seemed extraordinary in him, as a professed improver, to have employed any animal of acknowledged inferiority to his own; but I suspect the liberty he took in this respect, with impunity, could have only been taken with a high-bred stock of recent origin as his was, as many instances have since occurred in which a fine stock have been ruined in character, and have entailed irreparable loss on their owners, simply from being bred in-and-in.

6274. The immediate effects of breeding in-and-in, or employing parents nearly allied by blood to propagate their kind, are remarkable. The bone becomes very small, of condensed texture, and fine quality. The skin is so thin as to receive the appellation of *papery*, and so open of texture as to be sensible to the least change of temperature; and hence animals bred in-and-in are very

* Walker *On Intermarriage*, p. 307 to 353.

† Liebig's *Animal Chemistry*, p. 87.

susceptible of catarrhal affections, and on which account they are liable to consumption and clyers, (3816.) The carcass is much reduced in size, and the disposition to fatten increases to such a degree that the animal may be said to be always in a condition to be slaughtered; and it was perhaps this tendency to fatten which proved, several years ago more than now; the great inducement with many breeders to tolerate the in-and-in system. The hair is short, smooth, and thin-set, and the wool short, thin-set, and watery; and both hide and fleece lose a large proportion of weight. The body assumes a change of form, the barrel being beautifully rounded, but seems stuffed, as it were, within the skin. The extremities are very fine, the head and hoofs small, the ears thin and broad, and the head of the sheep is almost bare of hair, of a blue colour, very liable to be scalded by the heat of the sun, and attacked by the fly. The neck of both cattle and sheep are thin, and droop with a downward curve between the head to the top of the shoulder. The eyes are often affected with wateriness. Lameness frequently ensues in one of the limbs. The constitution is evidently much weakened. The points just enumerated show the unprofitable state into which a stock may be brought by being bred in-and-in. Mr Mason's fine Short-horn stock latterly showed symptoms of the bad effects of this system; and Mr Robertson's stock at Ladykirk, which contained at one time by far the finest Short-horns in Scotland, suffered after his demise from the same cause, as was apparent on the animals presented at the sale which dispersed them. Only cattle and sheep have been subjected by farmers to this unfair system, for draught mares are usually covered by stallions obtained from a distance; and of cattle and sheep, the system has been most practised on Short-horn cattle and Leicester sheep. The racing stud has perhaps experienced its injurious effects also. Now that high-bred stocks exist in every district of the kingdom, there is no excuse for pursuing the in-and-in system of breeding; and the attempt is the more inexcusable from the remarkable fact, brought to light only since the distribution of high-bred stock increased so much over the country, that the injured progeny, after being distributed for a time, their progeny may be brought

together to propagate, and their offspring will exhibit no symptoms of in-and-in breeding. Such a result would seem to indicate that change of soil and situation renovates the animal constitution.

6275. The idea of breeding in-and-in entertained by farmers, is confined to breeding by the members of the same family, let its branches be situate where they may. This is not the narrowest view to be taken of the subject, which Mr Walker assumes, and illustrates by examples. In considering in-and-in breeding, in its intimate nature, it is evident, he says, that, if close and strict, it abandons that method of difference between the two conjoined beings which he had shown to be necessary to excitement and reproductive power, and adopts the method, (not of similarity—for that he had shown to be essential to the production of every breed) but as it were, of identity. To explain this, let us take one of the strictest examples. Let it be that in which, of the animals subjected to in-and-in breeding, the father breeds with the daughter, and again with the grand-daughter. Now, it is certain that the father gives half his organisation to the daughter, (suppose the anterior or vital series of organs,) and so far they are identical; but, in breeding with that daughter, he may give the other half of his organisation to the grand-daughter, (namely, the posterior or locomotive series of organs;) and as the grand-daughter will then bear both his series of organs—the former from the mother and the latter from himself—it is evident that there exists between the male and his grand-daughter, as it were, an identity. The identity here is so perfect as entirely to destroy all the differences which are essential to excitement and reproductive power, the loss of which thus characterises in-and-in breeding. The case of brother and sister breeding together is nothing to this, and this is about the nearest of kin ever attempted by breeders; for, if the brother has the anterior organs of the mother, and the posterior of the father, while the sister has the anterior organs of the father, and the posterior organs of the mother, or contrariwise, there is scarcely any resemblance between them; and if, on the contrary, both have the same series of organs from the same parents, then are they merely similar, and neither, as in the case of father and grand-daughter, as it were identical. In the former case, no organ has been communicated from the one to the other; in the latter case, every organ has been so communicated.

6276. In breeding in-and-in, in even the ordinary method, when the male is enfeebled he no longer gives character to the progeny; and he is always enfeebled by breeding in-and-in, and even loses reproductive power. Close breeding impairs the constitution of both sexes, but the generative power fails first, and chiefly on the part of the male. Although the voluntary and locomotive power of the female is never so intense as that of the male, it is more frequently and repeatedly in action. In the male, the reproductive impulse is that of a moment, and

exhaustion follows it; in the female it can at any time be repeated. The vital and reproductive systems are in fact the largest and most essential portion of her organisation; but by no means of his. It is evident, therefore, why, when voluntary power is lessened in the male, it may be exceeded by that of the female; so that the failure in fact is chiefly on his part. Hence the law of breeding in-and-in, as enunciated by Mr Walker is, that where both parents are not only of the same variety, but of the same family in the narrowest sense, the female gives always the backhead and locomotive organs, the male gives the face and nutritive organs—precisely the reverse of what takes place in ordinary breeding.

ON CROSSING.

6277. The union of different breeds of the same sort of animal is a favourite scheme with many breeders, and, under certain conditions, produces good results. Those conditions are, that the male employed in the crossing shall have the superior breeding of the two parents, and that the situation in which the cross-progeny is brought up is suitable to it. The first condition is usually complied with, but the second is as commonly disregarded; and the consequence is, that crosses, attempted to be brought up in situations unsuited to their nature, have proved themselves failures.

6278. In the crosses commonly attempted in this country, among cattle the Short-horn bull, and among sheep the Leicester tup, have been employed to cross with the ordinary breeds of cattle and sheep. The results have proved satisfactory; for although the progeny could not be expected to be equal to the sire, they have in all cases been superior to the dam. The effects of the cross are, an enlargement of the carcass, a finer skin, longer hair and wool, cleaner bone, finer head, and the disposition to fatten greatly accelerated. In comparing crosses, it has been found that the higher bred the male the finer the cross—that is, the nearer it approaches his properties; and even an *over-bred* male, that is, one showing symptoms of having been bred in-and-in, may be used with advantage in crossing. Where a superior cross-male happens thus to be produced, a strong desire is evinced by breeders to use him as a sire, instead of expending money in the purchase of a high-bred male. A more

short-sighted step cannot be taken by a breeder, as from such a male no assurance can be obtained of the state of the progeny, which may be much worse than either sire or dam.

6279. There are situations in which high-bred stock cannot be maintained as a *breeding stock*, and in which nothing but crossing can be practised when improvement is desired; but the desire for improvement has been carried by some breeders beyond the bounds of prudence: they have crossed the Black-faced ewe with Leicester tups, in situations where the enlarged lamb has been unable to subsist in winter, on which account the policy of changing the Black-faced breed of sheep in high localities seems doubtful. This cross in the low country affords an excellent lamb for the table, the Leicester blood giving the disposition to fatten. In lower situations, the Cheviot ewe, which inhabits the middle range of green pasture, may be crossed with the Leicester tup with advantage. Where the Cheviots have been enlarged by size, it is alleged by the party possessing the pure breed, that the enlarged size has been gained by crossing with the Leicester, while the owners maintain that it has been done by good feeding alone. Every crossing, however, should be prosecuted with caution, because the result may overstep the intentions of the breeder. It is clear that if the crossed stock is retained as females, which, in their turn, are served by high-bred males, the time will arrive when the character of the original stock will be entirely changed, and become unsuited to their native climate and pasture, and will, in fact, have become the same breed as their high-bred sires. In this way it is quite possible to originate a race of Short-horns and Leicester sheep anywhere suited to their nature, by constantly employing a high-bred bull and tup to serve cross-bred heifers and gimmers, generation after generation. The pure Short-horns were thus once crossed with a Galloway heifer, whose blood was soon lost amongst that of the Short horn. Were the practice generally adopted, the time would arrive when the original breeds that were crossed would disappear altogether. Such a result would prove injurious to the breeder himself, inasmuch as the pasture would be

unsuited for the stock he had caused to be produced ; so that his best plan is to preserve the original females pure in the higher parts of the country, and take the crosses from them to the low country to be fed off. There is no other way of maintaining a cross, for were the cross itself used as a breeding stock, a few generations would either revert them back to their original breeds, deteriorated, or create a mongrel, the properties of which could not be preserved beyond the existing generation. The temptation of larger profits has already caused the Cheviot to drive the Black-faced breed from the lower to the highest mountain pastures ; whilst the cross-bred Cheviot, with the Leicester, have descended, on the other hand, to the low country, and have there met the true-bred Leicester. These results have done good, inasmuch as they have increased the quantity of mutton in the market ; and the skilful management which the pasturage on the hills has received since a regular system of breeding has been introduced, has caused it to yield a larger quantity of finer grasses. The crossing of the Black-faced sheep has undergone a change ; the Leicester tup is too heavy to serve Black-faced ewes on the hills, and to bring those ewes to the tup in the low country is attended with trouble and expense. Instead, therefore, of the Leicester tup being so employed, the Cheviot tup has been substituted ; and although the cross is inferior—for nothing can exceed the beauty of the lamb produced between the Black-faced ewe and Leicester tup—it is a good one, and has enlarged the Black-faced mutton. I am of opinion that the cross between the Southdown tup and the Black-faced ewe, would be a better one than with the Cheviot tup. I don't know that this cross has yet been tried, but the superior mutton of the Southdown would amalgamate better with that of the Black-faced than with the Cheviot, and the wool is superior to the Cheviot. So long as crossing is conducted with the breeds in their natural state, it will go on without confusion ; but the moment cross-bred tups are employed as improvers, their interference will produce confusion on the crosses and throw discredit on crossing altogether. I have crossed Angus cows with the Short-horn bull, fig. 565, and the

cross produced very fine animals for the butcher, with more disposition to fatten than Angus cattle possess. A notion exists, that, if a large bull is put to a small cow, the calf will be so large as that the cow will be unable to calve it. The notion can have no foundation in fact, since the fœtus is always in proportion to the matrix which contains it. It is true, however, that such a cross will cause severer labour to the cow in calving, in consequence of the increased size of the brain of the improved calf. The large Short-horn bull referred to above, was put to many very small Angus cows, and in no case occurred any danger in calving. The small cows produced small calves, but, having the disposition to grow and fatten from the bull, they thrived apace, after birth ; and it was on account of this property in his progeny that the bull was so sought after for their cows by the poor tenants of various estates. A cross was tried between the Southdown ewe and Leicester tup, with the view to adding some length to the Southdown wool, and the effect became permanent and proved itself a great improvement. When a Cheviot or Black-faced tup has been put to a well-bred Leicester ewe, the cross has possessed a worse and uncertain organisation than either of the parents. It is a wholesome species of crossing to take the males or females of a breed from one part of the country, to the males or females of the same breed in another part of the country. Although both stocks should have had the same origin, the change of climate, soil, and quality of food effect as great a change in the constitution of the parents as if they were different races. The cross with a high-bred stallion and any lower bred mare is always good. I have had some excellent harness horses out of draught mares, both by racing and coaching stallions. The cross received the figure and skin from the horse, and the action and constitution from the mare.

6280. The law of crossing, according to Mr Walker, is, that when each parent is of a different breed, and when both are of equal age and vigour, the male gives the backhead and locomotive organs, the female gives the face and nutritive organs. This law, in its effects as regards the domesticated animals, is very similar to those of the law of selection ; but in crossing the parents *always* maintain this relative position, while in ordinary breeding the parents change positions in proportion to the comparative

greater vigour of the characteristics of each, and when one imprints the prevailing characteristics the other stamps the opposite. The cause that, in crosses, the male gives the cerebel and locomotive system, is both striking and beautiful. If no being can desire that of which it is already in possession—if, on the contrary, it must desire most what it most wants, (if not incompatible) it cannot be wondered that, in crosses, when the desired difference is greatest, the male, whose desire is most ardent, should stamp the system by which he exercises his desire, the voluntary locomotive, upon the progeny. In regard to the importance of this law as regards the breeding of animals, the slightest consideration will show, continues Mr Walker, that if, of the two great series of organs described, each belongs entirely to a distinct parent, we consequently can neither derive in the progeny both series from one parent, nor portions of both from each parent; and every attempt to do so must be a failure, and consequently lead to mere loss of time and money. It, at the same time, indicates the natural mode of procedure. It moreover shows that, in a feeble or imperfect cross, bad as well as good combinations may be produced; but that such a progeny as presents the precise qualities desired must alone be employed in further breeding, while inferior progeny must be cast aside. The intermediate character of the qualities produced in crossing is owing, not to each parent imperfectly giving its share in the progeny's organisation, but to circumstances that, in their new combination, each series of organs acts with, and therefore modifies, the other.

6281. On the difficulty of maintaining a cross in a permanent form, Mr Walker thus explains his views: "Seeing that the operations of nature are simple, and never capricious, why does it frequently or generally produce a tolerable animal? Because if the cross is a feeble or imperfect one, the male, dependent only on relative energy, may give either the locomotive or the vital system, and not the precise one desired: and so may the female. In the one case, therefore, the cross will be a tolerable one; and, in the other, it will be an intolerable one. But the breeder having no notion that these two systems never go together from one parent, and having no idea of the entire difference which subsists between them, is incapable of distinguishing them. And why is it a breed that cannot be continued? Because, precisely as I have described above, the breeder next puts together two products of the first cross, without their due distinctions; and the consequence is that, precisely also as I have above described, he re-forms both the original breeds. But the fact is that able breeders have, either by accident or by keener observation, often accomplished all that they desire in this way. It certainly seems surprising that breeders having in any case seen a cross perfectly successful and eminently beneficial, should not have been led to inquire more closely and carefully into the circumstances under which it

occurred. As similar causes always produce similar effects; so similar conditions in crossing will always produce similar progeny, whether one cross or ten crosses be made. While great difference was sought for in the cross, similarity is sought for in the progeny it produces, for without that there could be no homogeneity or conformity of breed—it would seem to want permanence; nor can any cross ever be established without this similarity being obtained in its produce."

6282. These laws, enunciated by Mr Walker, may thus be recapitulated in brief terms: The law of Selection operates where both parents are of the same variety, when either gives the organs of sense, forehead, and vital system, and the other the cerebel and locomotive system: the law of Crossing operates where each parent is of a different variety, when the male gives the back-head and locomotive system, and the female the forehead, organs of sense, and vital system: the law of In-and-in breeding operates where both parents are of the same family, when the female gives the back-head and the locomotive system, and the male the forehead, organs of sense, and vital system. But no law is thought of in the common practice of breeding. Thus then we have, we will not say life, for that is merely a general term, but the two series of organs on which both life and locomotion respectively depend, in two opposite successions and combinations—variably in beings of the same variety, and invariably in those of different varieties, (crosses,) as also when closely and long restricted to one family, (in-and-in.)*

ON THE HIRING OF FARM-SERVANTS.

6283. Every operation has now been described and discussed in regard to the raising of crops and the rearing of live stock. It is now necessary to attend to a few matters which affect the relation subsisting between the farmer and his servants; and the first of these in their order must be the hiring of them into his service.

6284. *Married* farm-servants are usually engaged for the year, and the period at which they are engaged is about the beginning of March. This season of engagement is in every respect favourable to the servants, though not for the masters. The servants are thus secured in their new service long before the term of departure from the old; and the engagement being made early in spring enables them to put the summer crops into their new gardens,

* Walker *On Intermarriage*, p. 201 to 242.

possession of which is given them immediately after their engagement. The disadvantages attending so early an engagement to the masters are, that, having secured another service, indifferent servants have a temptation to do their work for the future in a slovenly manner, and malicious ones a long time to wreak vengeance against their masters by the ill-treatment of their horses—both, in the mean time, being regardless of remonstrance, or even sharp rebukes. Good and conscientious servants will be guilty of no dereliction of duty, even with the prospect of leaving a desirable situation; but then such servants are seldom parted with, and only from necessity occasioned by circumstances, not from choice.

6285. Various are the circumstances which cause a separation between master and servant. The servant may become unable for the work he has long performed; his wife may be a troublesome person—which, in fact, is not an unfrequent cause of a man being obliged to leave a good place; his family may be guilty of many peccadilloes, in despite of their parents' injunctions; the man himself may have a peevish temper, and the master a hasty one, and the one may give the other up in a moment of temporary irritation. I knew an excellent servant who gave up his place in a huff. He had time to think of his resolve before the hiring day, and when it arrived he set off early to the market-town, and, watching his master's entrance into it, went up to him with an earnest entreaty for a re-engagement, which was instantly made. As regards the farmer, an unpleasant son may have succeeded a judicious father; he may be unreasonable, and frequently find fault without much cause—an injustice which a well-disposed servant will not long endure.

6286. As no perfection can be found in either master or servant, it is obviously the interest of both to exercise mutual forbearance. The master should overlook many faults, provided he sees that the servant performs his duties from principle; and the servant should endeavour to please his master cheerfully, even in what he may consider his whims. If these rules were mutually observed, there would be fewer flittings at terms than is the case at

present. Both parties should consider that their new move may place them in a *worse* position than before. Nevertheless, it must be owned that a servant of slow habits, however honest he may be, is a great bar to the work of a farm that is carried on in a spirited way; and it is a constant source of irritation to retain a servant whose daily conduct excites suspicions of his integrity.

6287. *Unmarried* farm-servants, who live in bothlies, are usually engaged or re-engaged on the term-day; but those who live in their masters' house are usually spoken to, to remain in their service, 40 days before the term. Domestic female servants, and those engaged by married ploughmen to do farm-work, commonly called *bondagers* or *field-workers*, are placed on the same footing. All single servants are engaged for half-a-year only.

6288. Farm-servants are usually engaged in the hiring-market of the neighbouring town or village, and they seldom exhibit written characters from the masters whom they are serving, referring only to them by name: and should these be found in the market, inquiry is made; but if not, an engagement is made from appearance and conversation. This is doubtless an unsatisfactory mode of hiring, and, to obviate it, it has been proposed to open registers, in which the names of farm-servants of established character, and of places may be entered, on payment of a small fee by those who may desire to inspect them. The plan of such a registry was established at Forres in Morayshire, in 1838, by Mr Robert Mitchell, and it is said to have hitherto worked well. At the end of the first year, on 31st July 1839, the number of names entered on the list was 267; at the end of the second year, in 1840, it increased to 636; and at the end of the third year, in 1841, it had risen to 1110. Both masters and servants seem to approve of the plan; and I have no doubt that similar good effects would follow the establishment of a similar registry in every hiring market. "Such a registry would have, in the first place, the effect of procuring agreeable situations for servants of excellent character; and it would probably, in time, have the moral effect of show-

ing the careless servant that the industrious, obedient, and skilful will always be preferred; and this lesson, it is hoped, may have the effect of making the indolent and vicious amend the error of their ways."*

6289. On hiring every sort of farm-servants, I would recommend a clear understanding to be had with them; and the simplest plan of avoiding misconceptions of the duties to be performed by servants is, to hire them to do whatsoever they are desired. It is necessary to make this stipulation, for some servants are so fastidious as to the nature of their duties, that they will refuse to perform any other than what they were specially hired to do. For example, if a man has been hired to drive a pair of horses, he will cheerfully do whatever is done with the labour of the horses, but may demur to do any other work when his horses are not employed; and yet very urgent work may have to be done at a time when horses cannot be employed, such as letting off water from land, and many others. In like manner, a dairy-maid may refuse to feed pigs or poultry; and domestic servants may refuse to work out of the house; and it is no uncommon case to hear shepherds and gardeners refuse to do anything, however needful and conducive to their master's interest, but what is directly connected with their respective specific charges. It may be found expedient at a time for the shepherd to bind or fork corn at harvest, and for the gardener to cut grass for the work-horses; but these necessary operations may be refused to be performed by either, unless both have been engaged to do what they are desired. Of course, it is always best for labour to have it performed by those best acquainted with it; which being the case, it will be the interest of the master himself to use a wise discretion in putting the stipulation into practice. But circumstances may arise when a particular department of labour may require extraordinary assistance, and it would be a hardship on the master to be deprived of any of the means of labour within his power, to promote that one department, merely because the other departments of labour were not also at the

same time in need of extraordinary assistance.

6290. It may be useful to give a succinct view of the law of contract of hire between master and servant, to show the relative obligations which subsist betwixt those parties in Scotland.

6291. *Hiring*.—It is not necessary to give arles to servants when hiring them; and even after receiving them, servants may resile from the bargain, if it is the custom of the district, (Ersk. III. 3, 14.) Farm-servants are presumed to be hired by the year, if no period be agreed on, (Finlayson, 1829.) In this same case, (June 6, 1829, 7 S. D. 717.) a griever or farm-steward is held to be engaged for a year. If a servant is engaged for a shorter period than half-a-year, or longer than a year, a written agreement should be made out and agreed to by both parties, otherwise, on the servant denying the period, he may, in the first case, be found entitled to full half-a-year's wages. Either party may refer the engagement to the oath of the other, (Tait, Just. Peace, 450.) Should the servant be brought from a distance, it has been found that the hirer is liable in the expense of bringing him, but not in the expense of his return, unless otherwise agreed on, (Baird, 1799, 5 B. S. 514.) By 4th Geo. IV., c. 34, persons contracting to serve, and deserting their service after entering on it, are liable to imprisonment.

6292. *Master's obligations*.—The master is bound to receive the domestic servant to his situation, and give bed and board, should no agreement be made to the contrary, for the term of service, (Bell's Prin. sec. 184;) and he cannot compel a domestic servant to live out of his house, (Graham, Feb. 12, 1822, F. C.)

6293. *Responsibility of masters for servants*.—The master is responsible for injury done to third parties through the fault, negligence, or carelessness of his servants, while doing their master's business, but not for their criminal acts, (M'Laren, 1827.) The master is not liable for the expense of a medical adviser, called in by the servant, different from the family one; nor will he be liable should the illness of the servant be brought on by his own imprudence; but when the illness is brought on from causes arising in the course of the servant's duties, the master is liable in expenses, (Cooper, 1831, Car. and Pay. Reps.;) and the master, in this case, has no right to deduct the expenses from the servant's wages, (Lellan, 1829, Car. and Pay. Reps.)

6294. *Servant's obligations*.—Servants are bound to serve their master in everything relating to the situation they have engaged themselves for. They must be respectful to their master and his family, and in their general conduct avoid actions scandalous or of bad example. They have no right to absent themselves without leave, (Crawford, 1822.) They are responsible

for everything committed to their charge in the routine of their duty, but not for accidents, (Campbell, 1734.) They must accompany their employer in change of residence, as long as he does not leave the kingdom, (Tait, 462.) They have no right to draw nice distinctions between what comes under their duty and what does not; they cannot be employed on any duty different from the customary duties of the service they have undertaken, and this renders a specific agreement, to do what they are desired, necessary. Enlistment in Her Majesty's service frees a servant from his obligations by the Mutiny Act.

6295. *Wages.*—Should no wages be bargained for, none are due, (Salton, Brown, Sup. 3, 337.) The servant has a right to leave his master, and claim wages and board-wages, should his wages not be paid at the terms agreed upon. Though a servant is engaged by the year, his wages are payable half-yearly, (Tait, 465.) A servant, through sickness, disabled from doing his duty, has still a right to his wages, should no servant be got to supply his place, (White, 1794.) Should the servant die between terms, wages to the time of his death will be due to his representatives. When the master dies, wages and board-wages to the next term are due, should there be no agreement for any space of time. When the servant is engaged for any specified time, wages and board-wages are due to the full time. The master's bankruptcy gives the servants the same claim. But in both these last cases, on the servant's being supplied with another place, wages only for past services are due, (Tait, 465.) The master can, at any time, turn off his servant, on giving him full wages and board-wages, (Cooper, 1825.) A female servant marrying and leaving her master, loses all claim for wages, and her husband is liable in damages.

6296. *Grounds for dismissing a servant.*—A servant may be dismissed for immoral conduct, disobedience, or habitual neglect of duty, (Callo, 1831;) for absence on Sunday when ordered to the contrary, (Hamilton, 1824.) Absence for four days without leave was held a sufficient cause of dismissal; and legal dismission forfeits the servant's wages, (Silvie, 1830.) When either a master wishes to part with a servant, or the servant wishes to leave his situation, warning must be given 40 days before the term, otherwise the engagement is held to be renewed, (McLean, 1813;) unless the local custom is to give no warning, then none is necessary, (Morrison, 1823.) After a servant has received his wages and left his situation, he cannot say he got no warning, (Baird, 1779.) It will be observed that much of what has been said applies almost exclusively to *domestic* servants, whether on a farm or not; the relations of out-door farm-servants with their masters are so clear that few questions arise between them, either at parting or during the course of service.

6297. *Character to servants.*—The master is

not bound to give a servant a character, either oral or written, or to assign a reason for withholding it, (Carroll, 1800, 3 Esp. 201.) He will be liable in damages, when asked the character of a servant, in giving an untrue one, (Bell's Prin.) He will be justified in giving one prejudicial to the servant, if true, (Christian, July 6, 1818; 1 Mur. 427;) but he has no right to give out such a character publicly, without sufficient cause.

6298. *Hiring workmen.*—Workmen, like domestic servants, may be hired by the year, or for a shorter time, but writing is necessary for a longer period, (Paterson, June 17, 1830, 6 S. D. 931.) They are bound, besides the principal engagement, to keep to certain regular hours, and observe the same respect and decency as domestic servants. They may be compelled by imprisonment to fulfil their contract, (Clerk, Jan. 19, 1799, F. C.)*

6299. Of late years a movement has been made in the north-eastern counties of Scotland to abolish hiring-markets, and the abandonment of the lodging and boarding of a number of unmarried farm-servants in a single room, named a *bothy*.

6300. As to the abolition of hiring-markets, the attempt on the part of the farmers to do it will, in my opinion, prove futile, for two sufficient reasons. One reason is, that it has always been found a very difficult matter to change even the site or the day of any sort of market. What the public seems to have a general interest in, they will never agree to relinquish. The abolition could, no doubt, be done by act of parliament, but not otherwise; by no local arrangement can the end be attained. If such a difficulty attends the alteration of any market, there would be greater still in its abolition. The other reason is, that if hiring-markets were maintained in any part of the country, it would be found impracticable to abolish them entirely in any other part of the country. Now, hiring-markets are not attended with inconvenience everywhere. I have attended many of them in the southern counties of Scotland, and never saw anything reprehensible in them. The men and women mustered in the market-town in the early part of the day, transacted their business, and went home in the afternoon, and if any remained in the town until the evening, it was chiefly to visit friends; and if a few cases of intemperance occurred, it was long after market hours. It is, therefore, not fair to stamp the character of any meeting by the exceptional cases, nor is it fair to characterise all hiring-markets by the acts done at a few of them. I regard them as very convenient meetings, where the hirer and the hired have the best opportunity of learning the rate of wages, and where an abundant choice is presented to both parties of what they both came to seek.

6301. Nor can register offices ever supersede

* *Farmer's Lawyer*, p. 160-5.

hiring-markets. The mere registry of the name is not sufficient for the seeker in quest of character, as no one will dare to register publicly a bad character against a bad servant; and if the truth cannot be so told, there is no use of the registry at all—and there is no need of a registry for good servants, as their characters will obtain them situations anywhere, without the assistance of either hiring-markets or registers. A registry might be made a record of the names of good servants who are to be out of service at the ensuing term, and the hiring-market might serve as a good place for the parties to meet in, who may have to come from opposite quarters and from considerable distances.

6302. The bothy system, as it is termed, has much need of emendation, and, in my opinion, the only one it is capable of is its entire abolition; which it is quite in the power of any proprietor, along with his tenants and servants, to accomplish on any estate. The congregating of young unmarried men in one room, which is occupied both as a sleeping and cooking apartment, and the sleeping of two men together in one bed, are acts obnoxious to decency. Being under no control, one or other of the men wanders abroad during the night, and are of course unfit for their work during the day. They visit one another at their respective bothies, especially in winter nights; and it is seldom that a separation takes place without the accompaniment of intemperance. The inmates of bothies seldom remain long in the same service, it being almost impossible to find a number of men, associating daily and nightly so intimately as they are obliged to do, entertain the same sentiments on any one subject; and the consequence is disagreements, which can only be put an end to by separation at the ensuing term. The bothy system is recommended to be amended by hiring the men for shorter periods than six months, or even during pleasure, that their master may have the greater control over them; and it is stated that farmers of high standing, who have tried this expedient, find their men more diligent and careful, and remain longer in their service than when hired by the half-year.* This plan is but an expedient at best, and will result in palliation alone. An effectual method is to eradicate the system entirely; and the only way of doing it is by the erection of cottages by proprietors, for married men, or for householders, whether they be married or not, and the institution of a service such as has been long practised with the utmost success in Berwickshire. Nor is this a mere supposition. I had the experience of the bothy system in full vigour in Forfarshire, and had frequent opportunities of witnessing its baleful effects; I built cottages for the accommodation of married men, and ever after nothing but quiet and contentment; and the desire to remain, prevailed in every case at every term. Two of the bothy men themselves took wives, and received each a house and garden, and became steady ploughmen, who remained with me as long as I farmed. Let every proprietor and farmer do, in

the districts in which complaints are rife against the bothy system, as I did in Forfarshire, and the system will be abolished for ever. The expense of maintaining the men in their own houses may be a little more than in the bothy, but it will be trifling in comparison of the comfort purchased by it, both for master and servant.

ON THE WAGES OF FARM-SERVANTS.

6303. I enumerated the different classes of labourers employed on a farm from (57) to (67;) and I must here state that the wages of all of them may be classed under three heads:—Those consisting chiefly of *kind*—that is, of the produce of the farm, and but a *small* sum in *cash*; those consisting of a *large* proportion of *cash* and a *small* amount of *kind*; and those which consist *entirely* of *cash*. The recipients of the first and third classes may be engaged on the same farm, and the third class may be found exclusively on a farm, but the first and second classes are never found together; and as all three modes of paying wages co-exist in the kingdom, though in different parts of it, they afford a criterion for judging which is the best mode for all parties, for master and servant; which the most convenient for the master, which the most conducive to the servants' comfort and moral habits. Ploughmen or hinds, constituting the principal or staple class of labourers on a farm, like the battalion men of a regiment, the amount of their wages is taken as a standard by which to compare that of the other classes of labourers.

6304. Winter is the season in which *wages in kind* are paid to farm-servants; and the period of that season chosen for the purpose is about the end of the year. It is requisite that harvest shall be entirely finished, and every arrangement connected with the accommodation of stock, on turnips or in the stading,—made before the thrashing of the stacks in regular succession commences. After these preparatory operations, and before much of the new crop has been disposed of at market, further than to ascertain its general quality and price, the first leisure time from field work by stress of weather is taken advantage of for paying the farm-servants

* *Transactions of the Highland and Agricultural Society, July 1849, p. 14.*

their yearly wages of corn; and as the quantity distributed is considerable on a large farm, and as all the servants should receive their wages at the same time, to avoid envy, there will be a considerable quantity of thrashed grain in the barn before its distribution in wages takes place. The servants receiving a variety of corn, that variety should be first distributed which is found most convenient for the farmer to thrash; and one variety should be delivered, and the barn cleaned out, before another is taken in hand.

6305. *Ploughmen's wages*.—These are paid in all the three modes enumerated above (6303,) the first mode being in general adoption in the Border counties of England and Scotland; the second being practised in the midland and northern counties of Scotland; and the third being in general use in the midland and southern counties of England.

6306. Wages composed of *kind and money* differ, in their constituent items, in different counties, but only in a slight degree; the aggregate items affording sufficiency of food to support a ploughman and an ordinary family, and nothing to spare. The particulars enumerated received by the ploughmen are cashed according to the prices in 1850:—

6307. *Berwickshire.*

10 bolls = 60 bushels oats, at 2s. per bushel,	£6 0 0
3 .. = 18 .. barley, at 2s. 9d., ..	2 9 6
1 .. = 6 .. pease, at 3s. 6d., ..	1 1 0
12 .. = 1200 yards potatoes, at 4s., ..	2 8 0
A cow's keep for the year, ..	8 0 0
Cottage and garden, ..	1 2 6
Carriage of coals, ..	2 0 0
Cash, ..	4 0 0

Equal to 10s. 4½d. per week, £27 1 0

The turnips in winter for the cow amount to 3 double loads of swedes and 3 of white, or, in lieu, 60 stones of 22 lb. each of hay; and grass in summer. The rent of the cottage and garden is equal to one person's food in harvest that is, 30 days at 9d. per day, £1, 2s. 6d. The grain is next to the seed-corn in quality, and it is paid in slump or advance at the middle of the year's engagement. The ploughman has liberty to keep pigs, but no poultry. He disposes of both the calf and most of the butter from the cow.

6308. *Northumberland.*

6 bolls = 36 bushels oats, at 2s. per bushel,	£3 12 0
4 .. = 24 .. barley, at 2s. 9d., ..	3 6 0
2 .. = 12 .. pease, at 3s. 6d., ..	2 2 0
3 .. wheat, at 5s., ..	0 15 0
3 .. rye, at 3s., ..	0 9 0
40 .. potatoes, at 1s., ..	2 0 0
24 lb. of wool, at 1s., ..	1 4 0
A cow's keep for the year, ..	9 0 0
Carriage of coals, ..	2 0 0
Cottage and garden, ..	3 0 0
Cash, ..	4 0 0

Equal to 12s. per week, £31 3 0

The allowance of turnips in winter is 10 cart-loads of white, or 5 of white and 3 of swedes; or, in lieu, 100 stones of 22 lb. equal to one ton of hay. The rent of cottage and garden is £3, but for this the ploughman receives for food and wages 2s. 6d. per day for 30 days in harvest. The grain is paid in advance once a quarter. The ploughman has liberty to keep a pig, but no poultry. He disposes of the calf and spare butter from the cow.

6309. *East Lothian.*

12 bolls = 72 bushels oats, at 2s. per bushel,	£7 4 0
3 .. = 18 .. barley, 2s. 9d., ..	2 9 6
8 .. beans, 3s. 6d., ..	1 8 0
6 .. or 1600 yards potatoes, 3s. 100 yards,	2 8 0
Food for hind for 30 days in harvest, at 9d. } per day, ..	1 2 6
A cow's grass, ..	5 0 0
Carriage of coals, ..	2 0 0
Cottage and garden (free), ..	1 10 0

Equal to 8s. 10½d. per week, £23 2 0

One half of the oats to be made good up to the first fiars of the Haddington market, and a price fixed for the potatoes in case of failure. The cow receives from the farmer nothing but straw in winter. When the hind keeps no cow, £5 a-year are allowed him in cash. The cottage and garden are really free, the hind not being obliged to provide a reaper in harvest, whose maintenance is usually retained in other parts of the country as rent for the house. These items vary in the county.

6310. *Pfeshire.*

WAGES OF MARRIED FOREMEN.

Money,	£12 0 0
65 stones (14 lb.) of oatmeal, at 1s. 2½d. per st.,	3 18 6½
1200 yard in the drill of potatoes, at 3s. per } 100 yards, ..	1 16 0
House and garden, ..	2 10 0
Cow's keep, ..	9 0 0
Allowance of bread and beer in hay-time and } harvest, ..	0 10 0

£29 14 6½

Equal to 11s. 5d. per week.

WAGES OF MARRIED PLOUGHMEN.

Money,	£10 10 0
65 stones of oatmeal, at 1s. 2½d. per stone,	3 18 6½
182 gallons of new milk, at 6d. per gallon,	4 11 0
1200 yards in the drill of potatoes, at 3s. per } 100 yards,	1 16 0
House and garden,	2 10 0
Allowance in hay-time and harvest,	0 10 0
	<hr/>
	£23 15 6½

Equal to 9s. 3¼d. per week.

6311. Wages, *more in cash than in kind*, are more extensively given in Scotland than the plan which I have just described. Those who receive this species of wages are chiefly single men, living either in the farmer's house, or in a house by themselves called a *bothy*. The practice of allowing farm-servants to take their meals in the farmer's house is falling fast into desuetude. Married men are also supported in this form of wages, but their condition is not so good as that of the ploughmen on the preceding plan, although it is certainly preferable to that in the *bothy* system.

6312. The portion of wages received in *kind* consists of oatmeal and milk. The meal amounts to 2 pecks per week for each man—that is, 1 stone of 17½ lb., which makes 6½ bolls per annum, or 65½ stones of 14 lb., at 1s. 2½d. per stone, gives a money-value of £3, 19s. a-year. The milk is supplied either fresh from the cow or after the cream has been skimmed off, according to agreement. In the sweet state it is given to the amount of 1 Scotch pint or 2½ quarts a-day; and when skimmed, 3 quarts in summer, and 2 in winter per day. The milk is usually estimated at £4 a-year. In some cases a cow or cows are supplied to the men, who milk them, and are exchanged for others when they go dry; but supplying milk is the least troublesome plan for the master; because as long as the cows give as much milk as the men are entitled to receive, they make no complaint although the cows should give a great deal more than the stated quantity; but the moment the supply falls below the stipulated quantity, loud complaints are instantly heard. These items of *kind*, with from £10 to £14 a-year of cash, and even £18 in the time of railway high wages, constitute the earnings of a ploughman on this system. It is only in the amount of cash that these wages vary at any time, for what is given

in kind is considered invariable, being no more food than a stout man can consume; but some cannot consume it all, and save a part of the meal, which they dispose of. In strict fairness, the meal should be given to the men every week; but, to save trouble, it is dealt out once a month or fortnight. Besides the oatmeal and milk, bothy men always have a room in common, a bedstead and bed-clothes, fuel — partly brushwood and partly coals, one ton each—cooking utensils, and salt. They provide the dishes out of which they take their meals, consisting usually of a wooden bowl and horn-spoon. According to the previous rates of prices, with £12 a-year of cash, and estimating their lodging, wear of bed-clothes, and fuel at 25s. a-year each, the wages amount in money to 8s. 8d. per week. It must be held in remembrance, in regard to every case of the wages of a ploughman, that his wages go on whether he be working or not; so he has one advantage at least over the daily labourer, who may be thrown idle at every recurrence of bad weather.

6313. The ploughmen who receive *cash for wages*, are in the same condition as day-labourers, who receive their earnings once a-week, and purchase their subsistence from retail dealers in country towns and villages. This, I believe, is the condition of most of the ploughmen in the southern counties of England. It is obvious that, unless money-wages adapt themselves nicely to the fluctuating prices of the commodities upon which farm-servants subsist, the men must suffer much privation on a rise in the price of provisions; and, when these fall, they receive higher wages than they are entitled to. They are thus subjected to constant vicissitudes in their condition, from which the two former classes of ploughmen are entirely exempt. It signifies nothing to reduce the wages paid in kind to the latter into the money-value of the day, for, in fact, the ploughmen never receive their wages in that form, and are quite independent of fluctuations in price. The farmer has thus no temptation to dismiss men from his service when wages rise or prices fall in the market.

6314. The *wages of stewards* are in all respects similar to those of the ploughmen of whom they have the charge—the only

difference being in the amount of cash received, which is always greater than that given to the ploughmen. Instead of £4 with kind, they receive from £12 to £15; and instead of £12 or £14 with oatmeal, they receive from £20 to £25; and the best house is appropriated to them. In most cases the steward is exempt from attendance on the farm on Sundays, whilst in others he takes his turn along with the other men—the latter being the better plan for the master, as the steward has then a personal opportunity of knowing how the men have fulfilled their duties on that day.

6315. The *shepherd* receives the same amount of kind and money and accommodation as the ploughmen; but as he is accounted a skilful servant, and his hours of attendance extend every day from sunrise to sunset, he has leave to keep a small flock of sheep of his own, which is maintained by his master, and the produce of which he is entitled to dispose of every year. His flock consists of half-a-score of Leicester ewes, one-fifth of which are disposed of every year, and for which he is entitled to retain as many ewe-lambs of his flock as will maintain the full number of his breeding ewes. The dog is his own property, often purchased at a high rate, and trained with much trouble and solicitude. In the pastoral districts, the shepherd receives as wages 45 Black-faced sheep, which may be valued at 7s. each, 6 bolls of meal, a cow's keep, a cottage and garden, with potatoes. When the charge is extensive, two or three cows are allowed, and wages in meal and sheep besides given to the assistants.*

6316. The *hedger*, being considered a day-labourer, gets a smaller proportion of kind than married ploughmen, and more money, and generally no cow's keep; and where both men are no hedger is hired by the year, but is a day-labourer, and paid in money. Being a skilful man, the hedger never receives less than £40 a-year in value, and more frequently £1 a-week. He can sow corn, build stacks, and do anything that the steward can, and sometimes all that the shepherd does besides.

6317. The *cattle-man*, being viewed as

a labourer, receives some of his wages in kind and the rest in cash, and is seldom indulged with a cow. Being generally a person somewhat advanced in life, the rate of his wages is not high—perhaps 9s. a-week in money; and it is well when this post is held by an old and faithful ploughman or shepherd, whose growing infirmities disable him from undertaking full active duties.

6318. The *field-worker* is simply a day-labourer, and receives 10d. a-day in summer, and in some cases only 8d. a-day in winter, without any wages in kind. This person is usually a woman. The married ploughmen in the south of Scotland are each bound to supply a field-worker to work on the farm during the year, they receiving the wages earned by the workers. They hire the women in the public markets, and support them in their houses with bed, board, and wages. Should the field-worker obtain constant employment on the farm, the ploughman may profit by the arrangement; and on large farms field-workers are almost constantly employed. This obligation on the ploughman had, no doubt, arisen at a time when few women could be persuaded to work in the fields; and because he is obliged to hire them, they are designated by the odious name of *bondagers*. The obligation has been found fault with, and even represented as a species of slavery; but the fact is, there is no more slavery about the matter than in the case of the ploughman himself, who is bound by agreement to work for a year. The epithet is a nickname, although it is not used as such, but simply to contradict distinguish the female who is so hired from one hired to do service in the farmhouse, and even the latter in many instances works also in the fields. The practice is good, because it not only enables the farmer to command a certain number of hands at all times, but provides a number of accomplished field-workers in every district where it is practised: and the consequence has long been observed and known, that no such expert field-workers are to be found any where as in Berwickshire. No proper substitutes are found in the women to be hired out of villages, for, independent of

* *New Statistical Account of Scotland—Peeblesshire, Tweedsmuir*, p. 67.

many large farms being situate at a distance from any village, a village does not necessarily supply good field-workers, as I have myself experienced to my vexation; and whenever trade is brisk, manufacturers not only pick up all the hands they can procure in the villages, but the work being done by the piece, at which greater wages can be earned in long hours than at field-work, a temptation is presented to the women to desert the fields. Many manufacturers will not allow them to assist even at harvest. A resource of labour like the Border system should, therefore, not be yielded by the farmer until a better one has been established. Its hardships, however, are not felt by the workers themselves, but by the ploughmen, who must engage them; but any hardship can only press on the hind when he has no family and the work is very limited, and the support of a field-worker does then press hard upon his wages. But where the farm is large, the work in consequence constant, and the ploughman has daughters, the system is a continuous source of income to him, in doing the work in harvest, paying the rent of the house, and receiving payment for their labour — everything thereby contributing to the common fund of the family. The system can have no bad effect on the field-workers themselves, they being cheerful and happy at work, and well clad on Sundays. Nor are they ever required to do work beyond their strength; for although the “*unfeminine* practice of females driving dung carts”* has been stated as an objection against the system, field-workers would drive carts when necessary whether they were engaged in that mode or in any other; and, besides, the driving of carts is no more unfeminine than helping to fill them with dung, or turning dung-hills. But the fact is, women do not *drive* carts, in the usual sense of the term; they only lead the horse, while his driver is at more laborious work, to and from the dung-hill to the ridge which is being dunged. In the northern counties of Scotland, no such obligation as the engagement of field-workers exists on the ploughmen, nor can it coexist with the bothy system, where the ploughman has no house for him-

self; and hence in those parts field-labour, being performed by casual field-workers instead of by those steadily trained up to it from early youth, is necessarily executed in a much inferior manner to that of the Border counties.

6319. On taking a review of the actual condition of all the labourers of the farm, as I have endeavoured to represent it, and comparing the conditions of the married ploughmen and the bothy men, the question that occurs to the mind is—Which is in the best condition? My conviction is, that the ploughmen on the Borders are in the superior position. Let us look into one of their cottages of an evening, inferior as many of their cottages avowedly are, and “you will probably see,” to use the words of Mr Grey, Dilston, “assembled the family group round a cheerful coal-fire—which, by the way, is an inestimable blessing to all classes, but chiefly to the poor of this country—females knitting or spinning—the father, perhaps, mending his shoes (an art almost all acquire)—and one of the young ones reading for the amusement of the whole circle.” “Contrast this,” continues Mr Grey, “with the condition of many young men employed as farm-servants in the southern counties, who, being paid board-wages, club together to have their comfortless meal in a neighbouring cottage, with no house to call their home, left to sleep in an outhouse or hay-loft, subject to the contamination of idle companions, with no parent’s eye to watch their actions, and no parent’s voice to warn them of their errors; and say, which situation is best calculated to promote domestic comfort, family affection, and moral rectitude?” Contrast this with a bothy in the winter evenings, when it is the scene of lewd mirth—excited probably by the company of females who have come perhaps from a distance to visit their acquaintances, and who are treated most probably with stolen viands, entertained with profane jests and songs, and afterwards convoyed homewards amidst darkness and wet.

6320. “One very obvious benefit,” observes Mr Grey, as regards the married ploughmen, “arising to the hind from this mode of paying in *kind*—besides that having a store of wholesome food always at command, which has not been taxed with the profits of intermediate agents—is the absence of all temptation which the receipt of weekly wages, and the necessity of resorting to a village or town to buy provisions, hold out of spending some part of the money in the ale-house, which ought to provide for the wants of the family; and to this circumstance, and to the domestic employment which their gardens afford in their leisure hours, we are probably much indebted for the remarkable sobriety and exemplary moral conduct of the peasantry of the north; it gives him a personal interest in the produce of his master’s farm, and a desire to

* *Report of the Cottage Improvement Society of North Northumberland for 1842, p. 51.*

secure it in good condition; it produces a set of local attachments, which often lead to a connection between master and servant, of long continuance."*

6321. Beneficially as this system of paying farm-servants in kind has long operated, both for master and servant, it has been stigmatised by persons even in parliament as being only another form of the *truck system*, which has, as is well known, acted so prejudicially against the interests of the operatives of England. Before meeting this objection, let us inquire what is the truck system? Of the truck system, Mr Macculloch says that it is "a name given to a practice that has prevailed, particularly in the mining and manufacturing districts, of paying the wages of workmen in goods instead of money. The plan has been for the master to establish warehouses or shops; and the workmen in their employment have either got their wages accounted for to them by supplies of goods from such *depots*, without receiving any money; or they have got the money, with a tacit or express understanding that they were to resort to the warehouses or shops of their masters for such articles as they were furnished with."† If this be anything like a correct account of the properly reprobated truck system, it is clear that it has no affinity whatever to the payment of wages in kind, inasmuch as this has no reference to the *money-value* of any article which the hind receives—and they *always receiving the same amount of kind*, of course receive the same rate of wages; whereas the truck system has undoubted reference to the *money-value* of the articles dealt out to the operatives; and that money-value is fixed by the master, whose interest it is either to keep it at as high a rate as practicable, or else to give out articles of inferior quality above their worth; and hence the artisan does not always receive the same amount of goods, and is therefore not in the condition of the hind.

ON THE FARM SMITH, JOINER, AND SADDLER.

6322. *Iron, wood, and leather* compose the materials of which the implements of the farm are made; and these being in constant use, are always in a state of gradual decay, and require almost daily repair. To effect the repairs, it may be impracticable to send the implements to the nearest town, or even village. Where either exceeds one mile from the farm, much time is lost in taking everything thither, and bringing it back again; so that it becomes incumbent on the farmer to provide for his use a smithy, and a joiner's shop near at hand. As to

the saddler, his work requiring to be done at long intervals, he can be accommodated in the steading—the corn-barn or granary being a convenient place.

6323. *Smith-work*. — The degree of wearing to which the *iron* of the implements is subjected depends, in a great measure, on the nature of the soil of which the farm is composed. When the soil is sharp and gravelly, it wears down iron much faster than when it is clay or soft mould. The iron that wears most in work is that belonging to the movable parts of the plough, such as the coulter and share; and the shoes of the horses. To protect those parts from wear as much as possible, it is usual to point and edge the coulter and share, and to tip the horses' shoes with steel, which, although incurring greater expense at first, is an economical expedient in clay and soft soils, inasmuch as the plough-irons used in that class of soils only require repair every few days. But in sharp and gravelly soils, steel is a useless expense, for it is found to wear down almost as fast as iron; and it is therefore more economical to sharpen the plough-irons every day, than to lay them with steel. To some other implements, as the harrows, grubbers, &c., the same remark applies; and as to those which are seldom used, the difference of expense attending their repairs with iron or with steel is immaterial.

6324. In horses' shoes, it is their fore-bit which first wears down; and, as long as the horses are confined to the farm, there is no harm in their shoes becoming thin, provided the crust of the hoof is protected from injury by the ground. In some parts of the country, the shoes of farm-horses are made in a preposterous fashion. They are thick and heavy, being provided with high caulkers and broad and thick fore-bits, elevating the horse a considerable height above the ground, and endangering his tramping himself in the turnings at the landings, or in backing and turning in the cart. All that is required is a slight turning up or thickening of the heels, and particularly of the outer heels, and a little thickening of the fore-bit of the shoe, (1546) to (1556.)

* *Journal of the Royal Agricultural Society of England*, vol. ii. p. 186-8.

† *M'Culloch's Commercial Dictionary*—art. *Truck System*.

On disusing the high shoes myself, against the practice of the country where I farmed, the smith assured me that lameness from straining would soon overtake the horses; but, notwithstanding his forebodings, not a single case of tramping or lameness ever occurred afterwards. Tramps are dangerous, besides causing blemishes on the foot; for, when serious, they may cause quittor, which may terminate in ring-bone, and in consequence chronic lameness.

6325. The horses should not be neglected in their *shoeing*. It is not an unfrequent neglect to allow the shoes to remain on till they become loose, or the crust of the hoof grows beyond them; in either case the horses run the risk of being lamed, and, if not moving upon soft earth, they would inevitably acquire thrushes and corns. The shoes should not be allowed to be worn so thin as to endanger their breaking, nor to remain so long on as to get a seat into the hoof. When the shoeing is taken by the smith by contract, he is apt to persuade the men to let the shoes hang on as long as they can; but the steward should see to the state of the horses' feet, and order them to the smithy whenever he conceives it necessary. I am aware that shoeing often interferes with the time for field-work; but, in the busy season, the horses should be sent to the smithy in the evening, with a bundle of grass; and when the smith has shoes ready forged, which he should always have, not much time need be lost.

6326. There are two ways of having smith-work executed on a farm, one by the job, the other by contract. The mode by day's-work is expensive: the jobs being multitudinous in the course of a year, no efficient check can be placed against fraud. The most satisfactory way is to have the business done by contract throughout the year; and the simplest mode of contract is to take, as a standard of expense, the upholding of the most active portions of the iron-work of a farm—namely, the plough-irons and horses' shoes. Taking these as a criterion, it has been ascertained from experience that £3 a-year for every pair of horses is a fair estimate of smith-work on a farm. For this sum the smith binds himself to uphold plough-irons, horses' shoes, and all the *malleable* iron of

every implement in use in working order throughout the year. It is not incumbent on him to *renew* any article, but only to mend it when broken, and repair it when worn. Every new article is paid for in full. In some parts of the country, smiths will not enter into contracts for upholding iron-work, as was the case in Forfarshire when I farmed there; and it is no want of charity to ascribe the unwillingness to a consciousness of being able to make more money by job-work.

6327. Few farms are so large as to afford full employment to a smith; and it is not the smith alone that must be constantly employed, but his apprentice also, whom it is necessary for him to engage, to enable him to get through the heavy parts of his work that require the use of the sledge-hammer, which the forging of shoes does. If the smith's forge is so conveniently situate as that the horses from three or four farms can easily attend it, the smith may execute all the work in his own smithy; but when a farm is too far off, a smithy must be erected for him on the farm, where he does up all his work for the time. In this case, it is not unusual for the farmer to supply the iron, coals, and tools, and the smith to contract for the labour only. Under any species of agreement, the farmer should insist on the smith having a large assortment of shoes ready forged, of sizes to suit the feet of the different horses, that no unnecessary delay be occasioned in the smithy when a pair require a new set of shoes. This condition is the more necessary, that smiths do not care how long they detain horses, provided they can secure the assistance of the ploughman at the sledge-hammer, and thereby save the expense of keeping a stout apprentice.

6328. *Joiner-work*.—The wear of the *wooden* part of implements is not sensibly affected by the nature of the soil. If a wooden plough is put to unusually rough work, such as trench-ploughing or tearing up old rough natural lea, its parts may become strained, and even broken, and require renewal; but ploughs are now generally made of iron, and are placed wholly under the charge of the smith. Carts, however, suffer much when stones are driven for buildings and dykes, and

tiles or stones for drains. In such a case, if old carts have not been purchased for the occasion, it is prudent in the contracting joiner to line the bodies of the carts with slabs of common fir or willow, to protect the proper lining from injury. I purchased a couple of old carts for 50s. a-piece, and also old seasoned horses to work in them, when there was much building and draining to be executed on the farm; and they withstood the rough work for three years, when they were disposed of.

6329. The contract with the joiner is also £3 a-year for every pair of horses, for which sum he binds himself to mend every article broken in the work, such as wheels, bodies, and shafts of carts, handles of the minor implements, and the wood-work connected with the other implements, and also to paint them. For a new article, such as a cart, wheels, or harrows, he is paid its price; nor does he uphold the field-gates, nor any of the gates about the steading.

6330. The accounts of the smith and joiner should be settled half-yearly, at the terms of Whitsunday and Martinmas. I take this opportunity of impressing upon you earnestly the great injustice done to a tradesman, by disappointing him of the settlement of his accounts when they become due. He has made his arrangements with those who supply him with materials, and he cannot keep his promise with them as long as his accounts remain unsettled; and, in consequence, his credit suffers and his profits are diminished. You ought to be made acquainted that, in general, tradesmen in the country will suffer considerable privation ere they will complain to their employers, in the fear of losing their custom. Credit is the source of much mischief to small tradesmen in the country. It is no doubt a good thing in the town, where a bank is ready to assist the industrious tradesman for a short time, but the business of agriculture ought on all occasions to be conducted in ready money. This is the understanding of every person who attends a fair in the country, and a market in the market-town.

6331. *Saddlery*.—The *saddler* usually comes twice a-year and repairs the harness—at the end of the work in autumn,

and immediately after the throng time in spring. He is either paid day's wages, and provides himself with leather and every other material, or these are supplied him; or he undertakes to support the harness in working order by contract. I have been accustomed to see saddlery repairs paid in day's wages; but when a contract is made, it costs 30s. a-year for every pair of horses. The parts of the harness that require most repair are the collars and saddles, where these are in constant contact with the horse's skin, and the paddings of which should be restuffed every half-year, and the cloth renewed, if threadbare or in the least rotten, which it soon becomes, by the sweat of the horses. The clippings of sheep, accumulated during the season, when washed and properly dried, coming from the coarsest part of the wool, make good and cheap stuffing for collars and saddles, (3939.)

6332. Care should be taken to mend every broken part of the leather, in order to prevent rain in winter and drought in summer penetrating into the interior of the harness, and rotting or hardening it. The best leather ought always to be used, as being the most thrifty in the end, and it consists of well-tanned ox-hide, (1836.) Untanned sheepskin is employed to sew on the capes of the collars. (6171.) Saddlers are not bound to uphold the iron-work of harness, such as plough-chains.

6333. Opportunity of a stormy day, when the horses cannot work, should be taken to *clean the harness*. Work in summer and autumn not only dirties, but renders the leather of harness very dry; and if allowed to be long in that state, it cracks. The harness should first be washed *clean* with a sponge and warm water, and hung up for that day to dry. The next day it should be rubbed over with a bit of flannel steeped in sweet linseed-oil, particularly on the outside; for the side constantly next the horse's skin may not require oiling at all, though it will require washing to remove incrustated perspiration and hair. If blacking is used at all, it should not be put on until the day after the oil has been absorbed by the leather; but I see no use of blacking at all, save only to make the harness *look* better. The blacking, when used, should be of the best

shoe-blackening, which costs 1s. per quart bottle; and if judiciously put on with a soft brush in small quantity, and brushed firmly with a hard one, it will go over a large quantity of harness. The lamp-black commonly used for the purpose is filthy, coming off and staining everything in the first rain; and the common train-oil, usually employed to soften the leather, is still more filthy, being not unfrequently daubed on with a wisp of straw upon encrusted dirt, (676) to (686), and (1832) to (1840.)

6334. It is the *interest of the contractors* to make efficient repairs in all those materials, and not to allow the wear of the implements to proceed so far as to cause repairs nearly as extensive as a renewal; and, on the other hand, when repairs are paid in day's wages, it is as much the tradesman's *interest* that the same implement shall require frequent repairs. So well practised is this manoeuvre in some places where jobs are paid by day's wages, that ploughmen are bribed by the smith to bring their plough-irons, and even their horses, in turns to the smithy every night, whether repairs are required or not; and they are also bribed by the joiner to break the helves of the minor implements whenever they come much into use. Such a species of roguery, it is hoped, is rare; and I do not speak of it from my own experience, but from that of others, although I am not unwilling to believe it. The steward ought to take a strict cognisance of all repairs, and detect every attempt at roguery.

ON THE CARE DUE TO THE IMPLEMENTS.

6335. The farmer is often charged with neglecting his implements, by unnecessary exposure to the weather; and the charge is partially well-founded, although those who make it do not understand the cause of the apparent neglect. Implements are used both within and without doors; and those used without doors may be divided into such as are in use every season, and only occasionally. It is scarcely to be expected that implements very frequently used in operating upon the soil, can be otherwise than constantly exposed to the weather. Fortunately, on the score of economy, the implements thus employed are of simple

construction; and are therefore less affected by changes of the weather, as well as less costly when renewed, than those of more complicated construction, which are used for a short time at certain seasons.

6336. The implement most frequently in use is the *plough*, and, being the chief one for operating upon the soil, is constantly exposed in the field. When it was commonly made of wood, exposure caused its decay much sooner than now; when it is wholly constructed of iron. Of so much use is the plough, that, were one to be seen stowed away in the implement-house, the conclusion would instantly be drawn that it was an old and worn-out one, or so ill-constructed and useless that it had to be set aside. Fig. 552.

6337. *Harrows* being the implement most commonly in use next to the plough, are much in the field, and exposed to the weather; and, though made entirely of wood, last a long time. Not being required in winter, they are then removed from the field, and placed in the implement-house. The tines are usually laid and made sharp once a-year, and winter is the most proper time, just before the commencement of the oat-seed in spring. Harrows and ploughs are seldom painted after being made; but the harrows should be cleaned and painted when set past. Fig. 553.

6338. The *roller* being only occasionally in use, in pulverising the soil, and rolling the young grass and spring crops in spring, and in pulverising the soil in summer-fallow, it is replaced in its shed whenever its services are no longer wanted. It should always be set past in a state of complete repair, that disappointment may not ensue at the moment it is desired to employ it; and the wood-work should be painted occasionally.

6339. The small ploughs, such as the *ribbing* and *double mould-board plough*, being used chiefly in summer, are allowed to lie too long in the fields after their employment has ceased; and, if removed before winter sets in, are placed in the implement-house dirty and worn. When no longer required, they ought to be scraped clean of earth, and the irons laid, before being put aside in the implement-shed.

6340. There are few implements which receive less regard, when not in use, than the whole class of *scufflers* and *grubbers*, which get leave to remain at the sides of head-ridges, and corners of turnip and potato fields, perhaps the whole winter. Many of them being made entirely of iron, do not suffer much, it is true, of deterioration from weather; but, being composed of many small parts—of tines, coulter, wedges, and screw-bolts—these suffer from exposure, and execute their work indifferently on becoming worn. Instead, therefore, of being permitted to lie disregarded in the fields, their worn parts should be immediately repaired, and themselves placed in the implement-shed.

6341. All the classes of the more delicately constructed machines, as the *grass-seed*, *drill-sowing*, and *turnip-sowing machines*, are seldom allowed to remain longer in the field than when in use; but, though removed from the field, they are too frequently allowed to remain unheeded in the neighbourhood of the steading for a considerable time. Some, having no better place to put them, take them to the stack-yard and cover them with straw. Instead of this treatment, they should be immediately repaired, taken to pieces and cleaned, the journals greased, and the separate parts stowed away in the implement-house.

6342. The class of small manual implements, as *turnip-hoes*, *spreading-graips*, *dung-hawks*, *hay-knives*, *scythes*, if not placed in the implement-house whenever not in use, many of them will be lost. When scythes and hoes get worn, they should be thrown into the old-iron store, and their helves furnished with new ones.

6343. Of all implements, *carts*, perhaps, receive the worst treatment. Though much in use in the fields, they are never left there, it is true, and are brought to the steading, but too seldom are put under cover, and are exposed to every species of weather—whether to the shrinking power of the sun's rays in summer, or the rotting effects of the damps and rains of winter; and, considering that carts are constructed of many parts, the wonder is they last so long with the treatment they receive. Their axles are not unfrequently

neglected of grease; and as to their bodies and wheels being washed, not a mop is used or a drop of water ever thrown upon them—and they only receive ablution from a shower of rain, or an occasional passage across the ford of a river. A hole in the bottom or sides gets leave to enlarge, and a wheel-ring is allowed to become loose, till some day it flies off altogether, to the risk of breaking down the felloes. When such a mishap occurs from home, it tells strongly against the steward's attention to his duties, and places him in an awkward position with his master.

6344. All the in-door implements, as the *thrashing-machine*, should be cleaned out thoroughly every time a different kind of corn is to be thrashed, otherwise the samples of grain will be rendered impure. The gudgeons are usually oiled every time the mill is in use, (1746.) Wherever a thrashing-machine requires repair it should receive it immediately, otherwise a serious and expensive fracture may ensue.

6345. *Holes* in *sacks* and in *barn* and *chaff-sheets* should be instantly repaired, by patching and darning; nor should a broken mesh in a riddle be overlooked, so as to render the trouble of clean-winnowing grain unavailing.

6346. The *fitting up of the implement-house*, for the accommodation of the finer and smaller implements, should be so done as to keep the floor nearly unencumbered, and give free access to every particular implement required at a time. Wheels, loose shafts, and angular pieces of iron, are best suspended against a wall from iron bolts. Articles of length, such as sowing-boxes, are best supported against a wall upon brackets. Small articles of iron and of other materials, are best kept upon shelves. Hand-hoes, weed-hooks, and suchlike, are best placed in framed stands. Scythes are best suspended from the balks, and where are no balks from nails in the wall. The bodies of small ploughs, grubbers, scufflers, should be placed along the foot of the walls, and kept in their position with cords fastened to staples driven into the walls. If every implement were put into its own place at the end of its season, confusion would be avoided, and many more articles find accommodation in

the implement-house, than when everything is put down anywhere, without regard to order. To maintain order in the arrangement of the implements in the implement-house requires firmness on the part of the steward; but the enforcement of order carries this conviction with it, that it is easier to put a thing in its own place than anywhere else, inasmuch as the place allotted for it contains and retains it in the best state and position. The cart-shed V, Plate II., forms a good store for all the larger implements against the back wall; and were cross-beams put upon the wall heads, they would contain many others. The smaller implements would be well stowed as directed above in the large out-house *g'*, which might also answer for other purposes.

ON MAKING EXPERIMENTS ON THE FARM.

6347. It now only remains for me to notice a few subjects which personally affect the farmer himself; and the first of these is, when he makes experiments in the field, the plan he should follow in conducting them.

6348. The farmer may be regarded as a great and constant practical experimenter; for although all his operations are supposed to produce known results, yet the actual results obtained are often not as anticipated. When he works his land for wheat or for turnips, the operations being directed to a special end, he is certain of reaping a crop of wheat or of turnips, and thus far he does not run the frequent risk of an experimenter—a total failure; but the amount of crop obtained may be very different from what he expected—it may be better, or it may be worse. He may work his land in the most favourable circumstances, and after all reap but a scanty and ill-conditioned crop; or his operations may have been frequently interrupted by the weather, yet he may be rewarded at the end of the season with a bountiful return. Uncertainty of result attends not one, but all his crops; and it is not confined to the operations connected with one, but extends to those of every season. In this view, no profession depends so much on future contingencies as farming. Unless the manufacturer wishes

to make an alteration in his machinery, or in the pattern, fabric, or colour of his manufacture, he may go on producing the same results for an indefinite length of time. The farmer, on the other hand, cannot produce any determinate result;—he is more likely either to fall short of, or to overshoot, his mark; and it is to the intermediate result, between the two extremes which the farmer experiences, that the idea of an average crop is attached. Unless a correct idea of such an average has been formed, the comparative yield of a farm cannot be estimated from the crop of any one year. Whatever, then, a farmer does on his farm, may be regarded in the light of an experiment.

6349. Yet although his ordinary operations are attended with uncertainty in their results, they are not regarded or conducted by him as experiments, their uncertainty being anticipated. His true experiments, like those of other persons, are made to discover unknown effects, or to confirm dubious ones. Such experiments are constantly undertaken by farmers, not as a class, but individually; and they are conducted on a small scale, quietly, independently, unnoticed. The knowledge gained by such experiments renders him wiser, and their beneficial effects are evidenced in his improved practice.

6350. The present period, with farmers, is pre-eminently one of *experiment*. It is generally understood that experiments in farming are being made over the whole kingdom, and that they are now conducted by farmers as a class. The reason that *experiments* are more universally undertaken now than heretofore is, that they have not originated so much with farmers themselves, as at the suggestion of others. Many substances have been recommended to their notice as valuable manures, (4974,) of whose properties they were entirely unacquainted, and with whose ultimate results they are still unsatisfied.

6351. The farmers' position as regards their own operations, in as far as experiments extend, is uncommon and even anomalous. Experiment has placed all their operations in a state of transition; for, let its results be what they may, there is no doubt they will exert a power-

ful influence over the practice of the future, but whether it will be for the better or the worse remains to be seen. This state of uncertainty suggests to my mind a doubt of the results being so favourable to farming as are expected by the suggesters of the experiments. I am sure that the experiments will be conducted in sincerity, and the facts observed with care, though, perhaps, not at the time, and with the kind of observation they require; for, the experiments having been suggested by others, with substances with the nature of which the experimenters are unacquainted, the conclusions may not be legitimately drawn from the facts; and conclusions arrived at by other persons will carry no conviction to the minds of the experimenters themselves, inasmuch as the connection between the premises and such conclusions may not be obvious to them. The true way for the farmer to feel a personal interest in experiments is to obtain some knowledge of chemistry; and the only way for the scientific man to know what experiments to suggest, and what conclusions to draw, is to acquire some knowledge of agriculture. The united efforts of both parties, thus qualified, might then produce results which singly may prove nugatory, (210.) As you will, no doubt, be desirous of trying experiments, and may perhaps be placed in the position I have described of conducting experiments suggested by others, it may assist you in obtaining the results more satisfactorily to be made acquainted with a few practical rules by which all field experiments should be conducted.

6352. The primary object in every experiment should be to make it *comparative* in its circumstances as regards the field, soil, situation, time, and labour, with a crop raised in the ordinary way. Without making such an extensive comparison, no satisfactory conclusion will be arrived at, since no common ground would exist by which to measure the gain or loss obtained by the experiment. The experiment should also be made on the same kind of crop as the one with which it is compared. For example:—If the field is in lea, which it is intended to plough up for *oats*, then the proposed experiment should be made on *oats*, not on wheat, upon the lea; for

no elements of comparison exist between wheat and oats. The ground should also be ploughed in the same manner, which is a point of greater importance than may be imagined. I have known, in a field of lea, of strong soil, the ridges gathered up yield a better crop of oats than those cast together; and I have also seen gathered up ridges free from grub, whilst cast ones were affected by that complaint. Mr Stevenson, Redside, East Lothian, obtained a difference in the crop, on different ridges, whose furrow-slices lay in opposite directions. No reason could be assigned for either of those differences; but they were sufficiently observable to show, that one mode of ploughing land, and one aspect of the furrow-slices, affect the crop in a different manner from another mode of ploughing and another aspect. I have frequently heard it stated, that the crop on the furrows lying to the W. or to the S. is better than on those lying to the N. or the E. Some difference of effect must be produced by the aspect of ridges, for it is clear that a S. aspect will bear a better crop than a N. one, other things being equal. But even if the grain of the experiment and of the crop were the same, if the experiment were made in a different field, at a different period of the rotation, on a different kind of soil, in a different situation, and at a different season of the year, it is obvious that no common grounds of comparison would exist between the two cases, and the particulars of the one would be no guide for directing those of the other. Every particular in the cases must therefore be alike.

6353. Another important object should be to include as much land in each experiment as will allow it to be properly ploughed and treated. Land is usually ploughed in 2 or 4 ridges. If gathered up, (749,) cast, (755,) and ploughed crown-and-furrow, 2 ridges will suffice; but if ploughed 2-out and 2-in, (760,) or even 4-out and 4-in, then 4 or 8 ridges should be appropriated to each experiment, otherwise the results will not be *comparative*. And in all cases the ridges should run in the same direction. Instead, therefore, of previously fixing the *quantity* of land to be apportioned to each experiment, the *number of ridges* should be appropriated to each experiment *according to the mode in which the land had pre-*

viously been ploughed; and the quantity of land occupied by those ridges depends upon their length, so that the quantity may be $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, or 1 acre or more of land, as the case may be. Minuter fractions of land, such as $\frac{1}{8}$ of an acre along part of one ridge, will not do, because we have seen that two ridges must always be ploughed together, and their furrow slices must always be in opposite directions; and we have also seen that ordinary crops vary on furrow-slices, having different directions and aspects. As short ridges are never well ploughed, an eighth of an acre gives only 50 yards along two ridges, which is too short a distance to be ploughed as it ought to be; while, of course, a quarter of an acre would give 100 yards of ridges, which is short enough for good ploughing—and if longer, so much the better. I would say, then, that a quarter of an acre, along at most two ridges, is the least space of ground that should be taken to conduct any experiment upon.

6354. For these reasons, the experimental portions of ground should occupy ridges, and not rectangular patches staked out across the middle of the field. Patches may be differently affected by the weather—whether by rain, or sunshine, or wind—from the common ridges which stretch from one side of a field to the other. They may present different aspects at different parts of the field. The soil may differ in them. But entire ridges are more likely to have similar soil, similar aspect, and certainly similar treatment, in the same part of the field, than patches are likely to receive.

6355. In fixing the portions of a field for experiment, part of the ground should intervene in its ordinary state between each experiment; for the comparison will not be so fair over the entire field if the experiment be confined to a particular part of it, though it should extend across its whole length. When experimental portions are thus separated from one another, the ground of demarcation between each experiment will be so distinctly marked out that no risk of confounding the experimental plots can arise.

6356. The same experiment should be repeated on different ridges of the field.

Were each experiment confined to the part of the field in which it happened to be made in a patch, the comparison would be worthless, for both soil and aspect might differ in opposite sides of a field and at opposite ends of a ridge. Every experiment should, therefore, be repeated at least twice in the same field; and the more often the better.

6357. This injunction naturally leads to another, which recommends the experiments to be made with a very limited number of materials. Better make experiments in double and treble repetitions with three or four materials across a whole field, than one experiment only with twelve or fifteen materials. There evidently exists a strong desire in experimenters to try a large number of ingredients, and their mixtures, at one and the same time in the same field, thereby greatly increasing the trouble attendant in observing the minutiae of each experiment, enhancing the risk of error, and confusing the elements of true comparison. The reason for employing so many materials at a time is evident and natural; it is, that the larger number of materials may exhibit their results in the shortest time—but those results are of no practical use if not produced as comparisons with ordinary practice; and results cannot be compared when one ingredient is used in one patch of a field, and the ordinary crop is spread over it from side to side, and from end to end.

6358. Another very important consideration is the quantity of the ingredients used in the experiments. Some experimenters only apply as much per acre as amounts to a certain determinate cost; because, if the increased result derived from the ingredient does not amount to that sum, they are considered unprofitable. I consider such a principle based on error, because the market value of any ingredient is no test of its intrinsic worth; for we know that the guano which is sold for £10 per ton is worth three times, in its results, to that sold for £7. If, therefore, 2 cwt. of one ingredient give the same result, at the same cost, as 1 cwt. of another ingredient, it does not follow that the former is just as much worth as the latter; for, had it been lessened by chance to $1\frac{1}{2}$ cwt., the result might have been nugatory, and even injurious; whereas, if the 1 cwt. had been

increased to $1\frac{1}{2}$ cwt., the result might have been double to that obtained from the 2 cwt. The price of an article is, therefore, no rule to judge by of a manure, for that is dependent on the scarcity or abundance of the article, or the difficulty attending its manufacture. What I consider the most satisfactory mode of applying all ingredients, whose action is unknown, is to find out the largest quantity of each which will produce such an excess of crop as to do sensible harm, and also the smallest quantity of each that will produce a sensible effect. Having these two extremes, we have data by which to judge whether the price will permit you to purchase as much as will yield an increased and profitable crop. I see no other way of really getting at the true value of any unknown ingredient of manure.

6359. When a comparative experiment is to be tried with different kinds of manure, the land should be manured when in the same state, on the same day, at the same period of the day, and on the crop or crops at the same age; for I have obtained very different results from the same manure applied in the forenoon and afternoon of the same day on the potato, and on the turnip crop. It is the same with specific or a mixture of specific manures. For example, it will not do to try different specific manures upon grass which has been laid down after potatoes, against that laid down after turnips; nor upon a grain crop after turnips which had been eaten off with sheep, against the same kind of crop upon land from which the turnips had been carried off altogether. *Comparative* experiments could, no doubt, be made on these different conditions of grass, and of crop after turnips, were the *same* specific manure employed; but *different* specific manures will not give *comparative* results in different circumstances. In like manner, it will not do to apply *different* specific manures to *different* sorts of wheat, barley, or oats, as each variety of grain may possess such an idiocracy as to be very differently affected in similar circumstances, and the results obtained from such circumstances would not be comparative. Experiments may be made on different varieties of crop in different circumstances, without reference to comparison at all; but unless the *results of experiments are com-*

pared with ordinary practice, no practical use will come out of the experiment.

6360. Manures of whatever kind should be applied to the soil by the same means. One ought not to be applied by hand, and another by machinery; one in a dry state, another in a state of solution, if it be desired to make the experiment *comparative*. The states of the manures may be varied, but then they should be applied in the different states in the same circumstances as in ordinary practice, to render the comparison of any value.

6361. Every article applied to the soil in experiment should be weighed. There is no difficulty in weighing specific manures which are of little bulk, but ordinary manures cannot be weighed in a field without the assistance of a steelyard. I have often experienced this inconvenience in the field; but now the convenient machines manufactured by Messrs Craig and Co., Liverpool, (3639,) and Messrs Smith and Co., Paisley, afford every facility for weighing any article of manure, on the spot of the experiment, with the utmost accuracy and ease. The only *practicable* way of ascertaining the quantity of farmyard manure to be applied, where no steelyard is in the field, is to fill the cart with an ordinary load, and let special notice be taken how far the body of the cart is filled, in the loose state, before it is sent to the steading to be weighed on the steelyard—for I take it for granted that a large stationary steelyard is put up as a necessary machine at every steading; and if all the subsequent loads are filled to the same degree, by the same people, and with the same sort of manure, the weight of one cart from another will not differ materially. If notice of the bulk of the cart-load had *not* been taken *before* it was sent off to the steading to be weighed, the compressed state of the load, occasioned by travelling on the road to and from the steading, will give a wrong idea of the weight of the future loads. Every different cart employed should have the weight of its first load ascertained, as well as its own weight. Such apparently trifling matters are too apt to be overlooked, and yet it is they alone which give the power of conviction to any experiment.

6362. On collecting the produce of experiments, every article should be carefully weighed or measured. Corn should be stooked in the same manner, allowed to remain in the field the same time, and, if stacked, should be put in the same size of stack, built in the same manner. I attach more importance to this last remark on stacking than it may seem to possess, because I knew a stacker, the corn from the stacks built by whom always came out in raw condition; and the reason was that he did not heat his stacks sufficiently, (4623.) I observe that experimenters generally thrash and weigh the crop obtained by experiment immediately after it has been collected, instead of stacking it. The grain thus new thrashed from the ground is not in the same state as it usually is from the farm, where it is invariably stacked for a time before being brought to the market: it will be in a raw condition, and neither it nor the straw will indicate their true weights. The crop should therefore be stacked for a time, to equalise both the grain and straw in colour, weight, and condition. On taking up experimental turnips, the whole break should be taken up and weighed at the same time, as considerable risk of error will be incurred by taking up and weighing only a portion, and then measuring the entire ground at once. In removing the experimental crop, of whatever kind, an equal extent of the ordinary crop should be removed at the same time, and not a fractional part merely; and all calculations should be made from the entire extent of each portion of ground subjected to experiment, and not from a fraction. Attention to all such particulars involves much time and trouble, and creates no little anxiety of mind; but the time must be spent, the attention bestowed, and the anxiety endured, if we wish to arrive at the truth.

6363. In conducting experiments, the farmer has practical difficulties to contend with. He cannot manipulate himself—he must depend for assistance on his people; and though he must regard them as *assistants*, they are so entirely ignorant of the nature of the ingredients employed as to require not only to be taught how to conduct the experiment, but to appreciate its means: they being disposed to regard with contempt any substances as a *manure*

that is applied in small quantities. The surprising effects of small quantities of bone-dust and guano have tended much of late years to remove that prejudice from their minds. But, after all, they may commit such inadvertent errors, at the very consummation of the experiment, as to render its results entirely nugatory; and such errors are the more likely to be committed if any operation has to be performed in a different manner from what they have been accustomed to do them. Many experimenters have, doubtless, experienced great disappointment from even one inadvertent mistake committed by the thoughtlessness or stupidity of a moment. Delay the application of a single specific manure, or the sowing of a variety of seed, till the next morning, when it ought to have been done the evening before—mix a single sheaf from the produce of one portion of ground with that of another—weigh a single article wrong, whether of manure or of crop—set down the number of one article for that of another, and the entire experiment is rendered utterly worthless as to the proportions and comparison of results, and even the absolute results cannot be depended on. Incessant superintendence, therefore, on the part of the farmer himself, is the only chance of preventing the occurrence of one serious mistake.

6364. Not to encumber the subject of experiment with a multiplicity of objects, I have purposely only referred to experiments to be made in the field, to the exclusion of those which ought also to be made with live stock. With these the difficulty is at least equally great, if not greater, which I believe it to be, than with plants; for although all animals of the same kind and of the same age seem as much alike as are the same classes of soils, and the same food seems as much alike as the same sorts of special manures, yet the constitution of one animal is more varied from that of another than the functions of one plant are from those of another. It is therefore almost impossible to ascertain the comparative value of different kinds of food, when given to different animals of even the same age and condition. And even the same food administered to the same animal will produce different results at different times, in consequence of the

different state of the health of the animal ; and at a different season of the year.

6365. Noting the progress of experiments in the field is attended with immense difficulties. The soil is so varied in its component parts, the best manures are so varied in their composition, the constituents of plants are so numerous and various, and the vital force exerts so inexplicable an influence upon plants in relation to the soil, manure, and season, that to anticipate any result simply by a process of ratiocination is impossible. No mind can possibly trace the progress of action which is constantly going on in the soil and in the air, in reference to the growth and maturity of a single plant. When we, therefore, use a large number of means to produce a desired end, we only multiply the elements from which we have to draw deductions, and thereby the more increase the difficulty.

6366. We may obtain some definite notions of such a difficulty by considering the qualifications which a suggester of field experiments should possess, and they will be found to be neither few nor unimportant. He should know the substances of which the plant to be experimented on consists—the functions performed in plants by their organic and inorganic or mineral constituents—the functions of the several parts of plants—the habits and analogies of the species of plants on which experiments are to be made, and of their several varieties—of what the soil consists—the differences of soils arising from their geological origin—the effects of local geology and physical geography—the general habits, principal varieties, constitutional tendencies, and especially the structure of the digestive organs of the domesticated animals on which the experiments in feeding are to be made—the exact state of our theoretical knowledge upon points akin to those on which the proposed experiments are intended to throw light—the clear and definite end, practical or theoretical, for which the experiments are recommended to be undertaken. He must know what compounds of each of the substances which are present in the soil and in the plant are soluble—to what extent they are soluble—and in what way they affect the solubility of each other when mixed together in the soil, or in an artificial manure. Then he will know how to feed his plants ; when, and with what they have been fed ; and how to judge of an experimental trial—how far it has succeeded, or what may be the cause of its failure.

6367. "In the *maker* of the experiments, all this knowledge is not required. He cannot possess too much of it—for none of it would be superfluous or without its use ; but scrupulous fidelity and accuracy in all his proceedings, a careful observation and detail of appearances, and a conscientious record of results, are the most essential qualifications on his part."

6368. Notwithstanding the non-necessity here

pleaded for the experimenter being so highly qualified as the suggester, it is clear that he who is to conduct the experiment *ought* to know as much about it as he who only suggested it. When the suggester is an eminent chemist, and the experimenter a practical farmer, the latter is not expected to be so highly qualified in chemistry as the former. But what I would desire to see is, a series of experiments conducted in the fields by a thoroughly practical farmer who is also an eminent chemist. The results obtained under the observations and conclusions of such a man could not fail to carry conviction to the mind of every farmer and of every chemist. And, failing such a union of qualifications in the same person, the next best arrangement to afford satisfaction would be to see experiments conducted in the fields by a really intelligent practical farmer, and superintended by an eminent chemist.

6369. In regard to the use of special manures, it is necessary "to make use of only such substances as are more or less directly soluble in water," observes Professor Johnston. "And when mixtures of substances are employed, they ought to be in such a state of chemical combination as not to act upon and render one another insoluble. Where these two rules are neglected, the immediate action of the single substance, or of the mixture employed, is not to be depended upon, and may not become sensible within a given time. It is scarcely possible to judge of the effect of an application which is not in a condition to act immediately and to expend its action within a known period ; to compare it with the action of other substances ; or to say how far it may be a profitable one, and ought to be repeated or discontinued. Patents have been taken out in this country for patent manures, the peculiarity of which was, that such of their constituents as were readily soluble in water should not be rendered very sparingly soluble, and thus be liberated slowly in the soil, and slowly worked up by the plant. But the principle was a bad one, and hence the want of success which has attended both the manufacture, and the numerous trials from time to time made with those manures."*

6370. Another consideration in the employment of saline ingredients, in experiment, as manures, is that the different substances should be used in quantities corresponding to their chemical equivalents. The following is a list of equivalents amongst the salts mentioned :—

Carbonate of potash (pearl-ash),	69.2
Carbonate of soda (soda-ash),	53.4
Nitrate of potash,	101.3
Nitrate of soda,	85.4
Sal-ammoniac,	53.5
Sulphate of potash,	87.2
Sulphate of soda (dry),	71.6
Sulphate of ammonia,	80.3
Sulphate of magnesia (crystallised),	123.8
Sulphate of lime (gypsum),	86.6

For example, if an experiment is to be made with the nitrate of potash against the nitrate of

* Johnston's *Experimental Agriculture*, p. 6 to 37.

soda, 101.3 lb. of the nitrate of soda ought not to be taken, because 101.3 lb. of the nitrate of potash had been taken, but only 85.4 lb. of the nitrate of soda—which is its equivalent quantity to the preceding number of the other salt.

6371. As a further incentive to those desirous of conducting experiments, it may prove useful to give a few general observations on the action of manures which have now been established by pretty extensive experience. Farmyard dung is the paramount means of fertility on the farm, it is the farmer's sheet-anchor, and every other manure must be regarded only as auxiliaries. It is indispensable in a dry season, and superior to all manures then.

6372. Saline manures, as top-dressings, are better for the cereal crops than the phosphates.

6373. Phosphates are better for turnips, and yield more grain, than saline manures.

6374. Nitrogenous substances have a good effect on the weight of grain.

6375. Sulphated bones are not a good top-dressing for oats; they are better ploughed into the soil than as a top-dressing to any crop. They induce a large yield of the grain of wheat.

6376. Guano is invaluable to turnips, but is not a good top-dressing to any of the cereal crops. It is assisted by common salt in dry weather, and by sulphate of soda in damp.

6377. Common salt acts best in dry weather and on dry soils.

6378. Sulphate of soda acts best in damp weather, and is quite inert in dry weather in dry soils.

6379. Nitrate of potash and muriate of ammonia are dear special manures.

6380. Nitrate of soda and sulphate of ammonia are cheap special manures, and good top-dressings for the cereal crops.

6381. Two cwt. of the same saline manures applied early in the season, as a top-dressing, will produce as good an effect as 3 cwt. will do at a later part of the season. Special manures are particularised from (4904) to (5021.)

ON CORN MARKETS.

6382. The surplus grain of the farm is disposed of to corn-merchants, millers, bakers, distillers, and brewers. These attend on the market-day in the market-town. If the market-town is a sea-port, most of the corn-merchants and brewers reside in it permanently, and have their

granaries there. When the market-town is situate in the interior of the country, the merchants and brewers attend the market there from the nearest sea-port. In a corn district, from which most of the produce is carried away to large towns or manufacturing districts, it is most convenient for the shipment of grain that corn-merchants reside in sea-port towns. The purchase of grain is chiefly carried on in winter, when the farmer has his crop to dispose of. Brewers and distillers chiefly buy barley for malting, millers and bakers chiefly wheat and oats, and merchants every species of grain. The market for barley commences the season, wheat and oats being then disposed of according to the demand for them; but after March the demand for wheat and oats increases, to supply the consumption until next harvest, and that for barley decreases.

6383. Corn-markets are of two kinds, *stock* and *sample* markets. A *sample market* is that in which farmers bring a handful of each kind of grain they wish to dispose of, exhibit them to the purchasers, and deliver the grain at an appointed time and place.

6384. A *stock-market* is where farmers bring in the grain they have to sell in bags upon their carts, exhibit a bagful of it, sell the quantity brought, deliver it to the purchasers immediately after the sale is effected, and then receive the money for it. A merchant who *sells* grain in a stock-market does so by sample, and never thinks of bringing *his* stock, which perhaps consists of granaries-full, to the market-place; and therefore nothing exists to prevent farmers also selling their grain by sample in a stock-market.

6385. When sold by sample, the grain is *delivered* by the farmer in his own carts in the course of the few days allowed him for the purpose, either at the granaries of the merchant, brewer, or distiller, or at the mill of the miller. Water-proof tarpaulins are required to cover the sacks in the carts when grain is delivered in a rainy day; but it is better to defer the delivery until fair weather, if not otherwise inconvenient to any party.

6386. When sold in bags, corn is

delivered immediately after the sale at the granaries of the merchants on the spot, or at the brewery, or distillery, or mill in the country, according to agreement.

6387. The *payment* for grain sold by sample is only made on the market-day after the delivery has been effected; but the payment of that sold in bags is due, and is generally received, on the day it is sold, at an appointed time and place, after its delivery at the granaries.

6388. Of the two modes of selling grain, each has its advantages and disadvantages to the farmer. It is *very convenient* to take a quantity of grain to market, sell it, deliver it on the spot, and receive the cash for it immediately afterwards. It enables the farmer to transact his market business at once, and saves him the trouble of attending next market-day on purpose to receive the cash only, when he may have no other occasion to be there. It obliges, in a great degree, merchants to provide granaries for the reception of grain in the interior market-towns, as farmers may refuse to deal with a purchaser who wishes the grain delivered at a distance from the market-town, the fatigue to their horses being thereby probably much increased. This mode of selling grain has also the advantage of securing the farmer against bad debts, because, if he chooses, he may deliver the grain and receive the money for it simultaneously.

6389. This mode is, however, attended with this great disadvantage, that, in case the farmer does not sell his grain on the day he has brought it to the market-place, he is either obliged to take it home again, or put it into a granary until the next market-day, when, of course, a granary-rent is incurred, and the additional expense also of either hiring carts to deliver the grain next market-day, from the temporary granary to that of his purchaser, or of sending a cart of his own to do it; and if he keeps the grain so accommodated in his own sacks, he may be deprived of the use of them at a time when he may have a large quantity of corn in the barn to measure up. If he does not use his own sacks in this way, he must be accommodated with sacks from some party when he delivers the grain to the pur-

chaser, the next week, or whenever it may be. Railway companies are very accommodating with sacks to farmers who deposit their grain in the companies' granaries from one market-day to another, should they not dispose of the grain at the first succeeding one. Or, to avoid these manifold and obvious inconveniences, he must take the price offered for his grain. Another disadvantage is, that his horses must stand in the market-place, exposed for hours to cold blasts, after perhaps being heated on their way to the market-town. The exhibition of corn in bags gives power, however, to the purchaser to inspect the cleaning of every sack before purchasing it, and it also gives him the command of a quantity of corn immediately after its purchase, to make up a cargo.

6390. The *advantages* of a hand sample-market to the *farmer* are, that he is independent of the rate of price of any market-day; for if it does not satisfy him, he can return the sample into his pocket. His men and horses do not lose a day's work, and are not exposed to the weather in waiting in the market-place. He need not clean his grain before selling it; and should he be induced to sell more than that thrashed, he has time to thrash more and clean the whole quantity at once, thereby making the stock of uniform quality, and cleaning it agreeably to the purchaser's taste. The *advantage* of a sample-market to the *merchant* is, that, should the sample please him, he can purchase as large a quantity of grain as the farmer pleases to dispose of, and thus make up a cargo of uniform quality.

6391. The *disadvantages* to the *farmer* are inability to receive cash for the grain he sells until the next market-day after its delivery, and the risk he thereby runs of incurring bad debts with the merchant, to whom the stock is delivered some days before he pays for it; and the *disadvantage* to the *purchaser*—which, by the way, is most strongly felt by the brewer, distiller, and miller—is, that he cannot obtain possession of the grain immediately after the purchase.

6392. Of the two species of corn-markets, I prefer selling by the sample, in

a market which is attended by respectable purchasers, but chiefly because I dislike to see horses exposed for hours with a load in the market-place, and most probably in bad weather—for none other can be looked for in winter. Such an exposure cannot be for their advantage, and, in my estimation, the peculiar advantages of a stock-market are insufficient to counterbalance the risk thus incurred in the safety of the horses. The inconvenience is perhaps felt by some farmers, and a modification of the plan is followed, by delivering in the course of a few days a larger quantity of grain than was presented in the market-place. No modification can take place in the sale of grain by sample, because it is simply the presentation of the hand-sample in the market, the sale of the bulk therewith, and its consequent delivery at the specified time. It would be interesting to inquire into the particular diseases to which horses are most liable, that are exposed in a market-place for hours together, and to ascertain if they are the class of diseases most commonly contracted by exposure to weather.

6393. Every species of grain is directed by the Weights and Measures Act (5th Geo. IV. c. 74, sec. 15,) to be sold by the imperial *bushel*, fig. 168, containing 2218.192 cubic inches; and there is no such recognised quantity as quarter, boll, coom, or load. The practice has settled into measuring grain into half-quarter sacks of 4 bushels, which forms a convenient size of load; but the old designation of bolls, and cooms, and loads are still retained where they were in use formerly; and the confusion arising from the size of those different measures is as great as prior to the passing of the act, owing entirely to the defect in it, not making the size of the quarter and its fractional parts as imperative as that of the bushel.

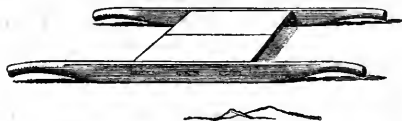
6394. Granaries in towns are frequently situate at inconvenient places for access to carts, as in narrow streets and lanes; and some are so inconveniently high, that four or five flights of steps have to be surmounted ere the floor be attained which is to contain the corn; and such stairs are not unfrequently too narrow and too steep, their steps being so worn in front as to

endanger the safety of the persons who carry loads upon them.

6395. For the carriage of corn from the granary to the ship, I have seen a convenient form of *bag* used. It consists of a short sack capable of holding rather more than two bushels, drawn together at the bottom, where a short piece of thick pliable rope is attached; the mouth being formed like any other sack. The person who is to carry the bag folds the mouth together when filled, so as to cover the corn, and at the same time leaves a portion of the sack loose, by which he holds firmly with his right hand. On assistance being given to lift the sack when filled with the sack-lifter, he turns himself quickly round with his back to it, and brings the loose part by which he holds on over his head; and, holding on there with both hands, he literally runs with the load to the ship's hold, where, on a man seizing the short rope at the bottom of the sack, and retaining hold of it, the carrier hitches the sack off his back, and the grain is poured into the hold. No other form of bag is so convenient for this purpose.

6396. A sack-lifter is a convenient implement, either in the granary of the corn-merchant or the corn-barn of the farmer. Fig. 589 is a view in perspective

Fig. 589.



THE SACK-LIFTER.

of one which is very similar to a common hand-barrow. It simply consists of two pieces of ash, 3 feet 9 inches long, terminating at both ends in the form of handles, and united together, at 15 inches apart, by means of three cross bars of wood tenoned and mortised into the handles. A boarding is placed over the bars for the sacks to stand upon. On being filled the sack is lifted upon the board, or it is filled while on the board, assistants taking hold of the handles, lift it up simultaneously, while the carrier turns his back to the load to receive it upon it.

6397. For long in Scotland, grain used

to be sold by *measure alone*, and for long it used to be sold in Ireland by *weight alone*; and both ways are objectionable. When the measure alone is used, a temptation is held out to measure the corn before it is properly cleaned, especially if it has been sold. When sold alone by weight, a temptation also exists to retain light corn amongst the good, with the view, in both cases, of disposing of the inferior grain at as good a price as the fine. But a check has of late years been established against both species of frauds, by the introduction of the element of weight along with the measure. Merchants know the weight of grain by its appearance and feel, and therefore, by trying the weight of a 4-bushel sack, they easily ascertain whether the grain is in as clean a state throughout the bag as at its mouth. But the adoption of the weight has given rise to a species of deceitful dealing. The purchaser offers a certain price for every specified number of pounds weight of the grain, without direct reference to the contents of the bushel; and some farmers are induced to sell on this plan, in the vain hope of being able to boast that they have sold their grain at such a price—wishing it to be believed that the price applies to the true bushel, when in fact it is received for so many specified pounds weight. The fair and common practice is, to ask a price for the grain per quarter, stating its weight by the bushel; and, of course, the heavier the grain, and better the quality, the purchaser will give the higher price for it per quarter.

6398. The usual denominations of corn-measures, based upon the imperial bushel, the standard of capacity, are these:—

4 Gills	= 1 pint,	contain	34 $\frac{1}{2}$	cubic inches.
2 pints	= 1 quart,	..	69 $\frac{1}{2}$	.. ..
4 quarts	= 1 gallon,	..	277 $\frac{1}{2}$	.. ..
2 gallons	= 1 peck,	..	554 $\frac{1}{2}$	.. ..
4 pecks	= 1 bushel,	..	2218 $\frac{1}{2}$	.. ..
8 bushels	= 1 quarter,	..	101 $\frac{1}{2}$	.. feet
5 quarters	= 1 load,	..	51 $\frac{1}{4}$	.. ..

6399. *Sale of Corn*.—In regard to the sale of corn, these settled points in law may prove useful for you to know: "In sale by sample, the buyer may decline the bargain, if the bulk does not correspond with the sample, (Parker, 4 Barn. and Ald. 387.) The delivery of the sample does not transfer the property of the bulk, (Hill, Jan. 20, 1785, M, 4200.) The price must consist in current money, either of Great Britain or some foreign country,

which has a determinate value put upon it by the tacit consent of the state; if in goods, it will be barter and not sale; and if illusory, it will be donation. The price must be certain, as well as the subject sold. It is generally fixed by the parties themselves at striking the bargain. Where a purchaser of oats, payable on delivery, temporised with the seller, and delayed to take delivery for a fortnight, during which period the price of oats rose, it was held that he was not entitled to demand delivery, (Craig, May 29, 1823, 2 S. D. 347.) . . . In sales of grain, the price is sometimes fixed by the Sheriff's fiars. In the case of Leslie, (Jan. 27, 1714, M. 1419 and 1678,) where there was an agreement to purchase grain without a price specified, it was held *inter alia*, that fiars' prices may be presumed as the sale between landlord and tenant; and that merchants are presumed to contract according to the current prices of the country where the bargain is made. As to the risk of sale after the subject is sold, the loss is to the purchaser, as in the case of Campbell, (July 15, 1748, M. 10,071,) and in the case of Tarling, (1827, 6 Barn. and Cres. 361.) But it was held in the case of Milne, (Feb. 1, 1809, F. C.,) that where the seller takes upon himself the delivery of goods at a certain place, it throws the risk of the goods, while *in transitu* to that place, on the seller. . . . Where the seller has delayed delivering the subject to the purchaser when bought, he is liable for the risk; but it is not considered delay, when the purchaser declines paying the price. Also, when a landed proprietor sells a certain quantity of grain of a particular crop to a merchant, without specifying any particular parcel, and the whole crop is destroyed, the loss is to the seller; but after such quantity of grain is measured, or otherwise prepared for delivery, the risk will be transferred to him; so found in the case of Hind, (7 East. 558,) Erskine, iii. 3, 7."

6400. *Hypothec*.—In regard to the landlord's hypothec over corn, restitution was given in the case of Scot, (June 11, 1673, M. 6223,) of corns bought from a tenant while under hypothec. Though, when bought in public market, where they had been brought in bulk, the purchaser was not liable in restitution; if bought only in samples, the landlord is entitled to restitution. This was held in the case of Smart, Dec. 10, 1793, and of the Earl of Dalhousie, Feb. 27, 1823, 6 S. D., 626.* So that a stock-market is safest for a merchant to buy in, and a sample-market is safest for the hypothec of a landlord.

6401. Of late a movement has been made against the continuance of hypothec. It is a natural enough desire on the part of corn-merchants who purchase from sample to remove the risk they incur on purchasing grain from a tenant who may be indebted to his landlord arrears of rent; but how any tenant can join in such a movement seems to me surprising, for, independent of the connection of the hypothec with the sale of grain, its power enables the landlord to

* *Farmer's Lawyer*, p. 136-8 and 47.

let his farm in safety with back-rent; and the practical benefit of a back-rent to an incoming tenant is a sum equal to as much capital on the entry to his farm. Were there no hypothec, the incoming tenant would have to pay half his rent at the end of the first half-year after entry, as the tenants of England do; but the landlord, being safe of his rent under the hypothec, does not exact the first half-year's rent from the tenant until he has first reaped the crop which enables him to pay it—and delay, in such a case, is equivalent to the tenant of the possession of capital at the entry to his farm, to the extent of one year's rent.

6402. In regard to the origin and nature of the right of hypothec, Mr Hunter says that, "the conclusion from the combined evidence is, that, about the end of the sixteenth century, the landlord's remedy was by distress, very like the English remedy, and that hypothec, as it now exists, had not then been recognised. Nor at the beginning of the seventeenth century does the term 'hypothec' appear in the decisions. In a case dated in 1611, the term used is the 'prevelege' of the landlord for the recovery of his farms. In 1623, the term 'hypothecated' is used for the first time. The doctrine gained permanency; and thenceforward distress ceased, and hypothec prevailed."

6403. "The right of hypothec, as known in Scotland, is not to be deemed a right of property; but a right arising from a tacit contract, necessarily inherent in, and inseparable from, the contract of lease. It gives the landlord a right to retain and recover from creditors and purchasers the produce, raw or manufactured, or the other effects over which it extends, conformably to the nature of the subject let. And in competition it gives a preference to the lessor over the lessee's creditors, with a few exceptions. From being in its nature tacit and general, it is necessarily exclusive of possession by the lessor, or of the specific appropriation by him of every particular subject, and the property liable to its operation remains to the lessee; but it is capable of being converted, by the legal process of sequestration, into a real right of pledge, after which it may be sold for payment of the lessor's claim. It is distinguishable from a right of lien or retention, which vests the lessor with power of keeping possession of the effects until the rent be paid, but not of recovering them, or of obtaining a preference, if the possession shall be lost by sale in diligence. The right is purely legal, and cannot be created by convention."*

ON FARM BOOK-KEEPING.

6404. It has long been alleged that farmers only know the state of their affairs in an imperfect manner, because they do not adopt any system of book-keeping.

The allegation is true in regard to farmers as a class, for very few keep a regular set of books; but many farmers know the state of their affairs very well, although they do not keep a regular set of books; and many now keep books that did not only a few years since.

6405. But, at best, farmers cannot keep a perfect set of books: it is quite impossible for them to put a value on every article they raise on the farm; and if it were possible—as some writers have attempted to prove, and failed—the labour would be thrown away. For consider the manner in which a farm is conducted, and the nature of many of the articles raised upon it. There are articles produced, and operations performed on the farm, of the pecuniary value of which no just estimate can be made. He cannot estimate, for example, the value of every stone of straw given daily to his live-stock as fodder or as litter; he could not even weigh every stone so bestowed; and the difficulty of making a correct estimate is increased, when he is not allowed to sell straw. He cannot estimate the accumulated amount of labour, both manual and mechanical, bestowed on every acre of land, before it yields its produce, when he does not daily hire the labour of the people, nor purchase the food of the animals which perform it. He cannot ascertain the value of every cubic yard of manure produced on the farm, whether in composts or in the court-yards, when he is not allowed to dispose of it at market; nor can he make a comparative estimate of it when first taken to the dunghill, or when applied to the soil after being fermented. He cannot put a value on every ton of turnips and other green fodder consumed by stock, nor can he weigh every ton so used. He cannot put a just estimate on the value of pasture. The exact weight of all these articles *could* be ascertained by the steelyard; but of what use would the estimate of their weight and money-value be, since they are not disposed of at market and turned into cash, except in the neighbourhood of large towns? In attempting to ascertain the weight of every article used on the farm, in conjunction with its ordinary labour, without the employment of addi-

* *Hunter's Law of Landlord and Tenant*, p. 673-5.

tional hands, he would soon find the most important operations of the field half neglected; and were he to employ additional hands for the special purpose, he would most likely incur greater expense in estimating those weights than the knowledge of the estimate would be worth. The weight of the straw given to the stock in litter might be ascertained; but how could the exact quantity of the litter be ascertained, when a part of the fodder passes away daily amongst the litter? And even with the fodder, how is its money-value to be estimated? for it will not do to debit the stock with the market-value of the fodder, since it has not been driven to market, nor any profit received for it, which the market-value of every article necessarily includes. Attempts at the estimation of such items may very well amuse the leisure hours of the amateur or the temporary investigator, but they do not suit the matter-of-fact business of the farmer. It is enough, and it is necessary for him to keep accounts of every article for which he receives cash on delivery from the farm, and every article for which he pays cash when he receives it on the farm. These two great divisions of cash transactions are all that the farmer need trouble himself with in putting down into books, for these include every transaction that involves the payment and receipt of money.

6406. The farmer's attention is frequently directed to the conduct of mercantile men who keep the most correct set of books, as an example to himself, but the admonition is given by men who do not understand the occupation of the farmer. The mercantile man can estimate the exact market-value of every article he buys and sells, and, by striking a balance between these, he may estimate his condition at any time; but, as I have shown, the farmer cannot do so with a very large proportion of the crops he raises. The mercantile man has numerous transactions with possibly a

large number of people, and he has well-paid clerks in his service, who keep his books for him in the most approved order. The transactions of the farmer are comparatively few over the whole year, and the largest number are confined to a particular season; so that the clerk engaged to keep his books would not only be half-idle, but his wages might consume a large proportion of the profits of the farm, and in some years sweep it away entirely. But the most expert book-keeper could not enter imaginary values of articles which are never turned into cash any more than the farmer himself.

6407. The common-sense view of the whole matter is this: Let the farmer keep only such books as he really requires to acquaint him with the state of his affairs. If he will attend to me for a short time, I will show him a set of books all filled up with the real transactions which have taken place upon a farm. He may safely adopt it as a pattern, and it will not entail upon him much labour throughout the course of a whole year. The theory of the system is simply this: Let the farmer take an inventory and valuation of his live-stock, implements, crops, cost of labour, and debts due to and by him at the beginning of every agricultural year, and he will see whether his capital has increased or diminished in the course of the year—it will increase by a larger produce and a higher price, and diminish by a scanty produce and a fall in price; let him keep a cash-book, which will inform him whether he has received or paid away more cash in the course of the year; and let him have an account with the farm, by which he will learn, whether the value of the produce he has been able to dispose of is greater or less than the cost of conducting the farm. It is clear that a knowledge of all these particulars will acquaint the farmer with the real state of his affairs at the beginning of every agricultural year. The following are the forms of the respective books referred to.

6408.

INVENTORY AND VALUATION OF STOCK ON 1ST OCTOBER 1849.

The following is a List of the Effects in my possession, and of Debts due to and by me on this the 1st October 1849:—

I. CASH—		L.	S.	D.	L.	S.	D.
On hand,		40	0	0			
In British Linen Co.'s Bank,		300	0	0			
					340	0	0
II. IMPLEMENTS,							
					300	0	0
III. HORSES—							
14 horses, at L.25,					350	0	0
IV. CATTLE—							
1 short-horn bull,		20	0	0			
6 short-horn cows, at L.12,		72	0	0			
10 steer calves, at L.4,		40	0	0			
5 heifer calves, at L.3,		15	0	0			
15 yearlings, at L.8, 10s,		127	10	0			
					274	10	0
V. SHEEP—							
240 Leicester breeding ewes, at 32s.,		320	0	0			
60 Leices'er draft ewes, at 32s.,		96	0	0			
290 Leicester hogs, at 21s.,		304	10	0			
320 Half-bred wethers, at 30s.,		480	0	0			
3 Leicester tups, at 60s.,		9	0	0			
					1209	10	0
VI. PIGS—							
3 sows, at 60s.,		9	0	0			
1 boar, at 60s.,		3	0	0			
20 pigs, at 22s,		22	0	0			
					34	0	0
VII. CORN—							
11 stacks wheat, 20 qrs. each, 220 qrs. at 36s.,		396	0	0			
10 do. barley, 30 each, 300 at 20s.,		300	0	0			
17 do. oats, 40 each, 680 at 16s.,		544	0	0			
					1240	0	0
VIII. SEED AND LABOUR—							
Upon 100 acres of turnips at 70s. per acre,					350	0	0
IX. DEBTS DUE ME AS PER LEDGER—							
James Marrowman,		30	0	0			
Thomas Butters,		45	0	0			
					75	0	0
X. I OWE TO MY LANDLORD—							
Half-year's rent due Martinmas 1849,		500	0	0			
Do. do. Whitsunday 1850,		500	0	0			
					1000	0	0
					4173	0	0
					3173	0	0
CAPITAL IN 1849,							
					L.3173	0	0

6409

CASH.

Dr.

Cr.

		Fol. of Ledger.	L.	S.	D.	L.	S.	D.
1849.								
Oct. 2	To cash on hand at this date,		40	0	0			
" 4	To farm for 60 qrs. of wheat, sold Isaac Marshall & Son, at 37s. 4d.		112	0	0			
" "	To James Marrowman, received from him balance due for wheat,		30	0	0			
" "	To Thomas Butters, received from him balance due for cattle,		45	0	0			
" 11	To farm, received from Isaac Marshall & Son, for 60 qrs. of oats at 16s.,		48	0	0			
" 17	To B. L. Co.'s bank, withdrew from them,		15	0	0			
" "	By farm, paid for 30 steers bought at Yarm, at L.7,					210	0	0
" 24	By farm, paid harvest expenses as per labour account,					71	8	10
" "	By farm, paid for 5 sacks of oatmeal, at 26s.,					6	10	0
Nov. 4	To farm, received from John Cloy, for 80 qrs. of oats sold him, at 16s.		64	0	0			
" "	By farm, paid John Irons, for castings for mill,					6	0	0
" 11	To farm, received for 35½ qrs. wheat, sold to James Cuthbert, at 34s.,		59	14	3			
" "	By farm, paid Phoenix Fire Office, one year's premium of insurance,					7	17	9
" 20	By farm, paid schoolmaster's stipend for year ending this date,					1	17	6
" "	By farm, paid labour account for half-year ending this day as per abstract,					134	11	6½
" "	To farm, received from shepherd for fallen mutton,		1	15	0			
Dec. 2	To farm, for 80 qrs. oats, sold Thomas Dewar, at 15s. 6d.		62	0	0			
" 25	To farm, for 40 wethers, sold Timothy Wood, at 34s.,		68	0	0			
" 30	To farm, for 60 wethers, sold Jacob Keyworth, at 36s.,		108	0	0			
" "	To farm, for 50 qrs. barley, sold John Newmann, at 20s.,		50	0	0			
1850.								
Jan. 1	To farm, received for 20 pigs, sold Edinburgh market, at 30s.,		30	0	0			
" "	By farm, paid for 25 pigs, bought at Berwick market, at 15s.,					18	15	0
" "	To B. L. Co.'s Bank, withdrew from them,		230	0	0			
			L.963	9	3	L.457	0	7½
Carry forward,								

CASH—continued.

		Dr.		Cr.	
		Fol. of Ledger.	L. S. D.	L. S. D.	L. S. D.
1850.			963 9 3		457 0 7½
Brought forward.					500 0 0
Jan. 1	By farm, paid half-year's rent due Martinmas 1849,				
" 6	To farm, for 24½ qrs. barley, sold James Marrowman, at 19s. 6d.,		22 12 0		
" 7	By farm, paid ironmonger's account for past year,				8 0 0
" "	By farm, paid sundries, their accounts, viz.—				
	Farrier,	L.5 0 0			
	Roper,	2 10 0			
	Mason,	4 10 4			
	Slater,	4 17 10			
" 13	To farm, for 30 qrs. barley, sold John Factor, at 18s.,				16 18 2
" 27	To James Marrowman, for 31 qrs. wheat sold him, at 35s.,		27 0 0		
Feb. 3	To farm, for 30 qrs. barley, sold John Factor, at 18s. 6d.,		54 5 0		
" "	By B. L. Co.'s Bank, deposited with them,		27 15 0		
" 20	To farm, for Adam Butters for 15 steers sold him, at L.18,				100 0 0
" "	By farm, paid for 15 steers, bought at Darlington, at L.7,				105 0 0
" "	By farm, paid James Cuthbert for 3 tons of cake, at L.8 per ton,				24 0 0
" 24	To farm, received from J. Cornbuyer, for 30 qrs. barley, at 19s.,		28 10 0		
Mar. 15	To farm, received for 100 wethers, sold at Edinburgh, at 32s.,		160 0 0		
" "	By B. L. Co.'s Bank, deposited with them,				320 0 0
" 17	To farm, received from J. Cornbuyer, for 61 qrs. barley, at 20s.,		61 0 0		
" 20	By farm, paid for 15 steers, bought at Darlington, at L.8,				120 0 0
" 21	To farm, received for 14 steers, sold at Newcastle, at L.18,		252 0 0		
" 23	By B. L. Co.'s Bank, deposited with them,				200 0 0
Apr. 1	By farm, paid saddler's account for past year,				8 0 0
" 14	To farm, received for 120 wethers, sold at Edinburgh, at 35s.,		210 0 0		
" 22	By farm, paid for lime, bought Sunderland kilns,				9 5 3
" "	By farm, paid for 15 tons of guano, at L.9 per ton,				135 0 0
" 26	To farm, received from John Factor for—				
	63½ wheat, at 3½s.,	L.116 3 1			
	27½ barley, at 20s.,	27 15 0			
" "	By B. L. Co.'s Bank, deposited with them,		143 18 1		
May 5	To farm, received for 48 pigs, sold at Edinburgh, at 30s.,		72 0 0		200 0 0
" 8	To farm, received for 16 steers, sold at Newcastle, at L.14,		224 0 0		
" "	By B. L. Co.'s Bank, deposited with them,				300 0 0
" 15	To Isaac Marshall & Son, for 20 qrs. wheat sold them, at 37s.,		37 0 0		
" "	To farm, received for 15 steers, sold at Newcastle, at L.12,		180 0 0		
" 26	By farm, paid labour account for past half-year, as per abstract,				130 7 8
" "	To farm, received from the shepherd for fallen mutton and skins,		6 15 0		
" 28	By farm, paid poor-rates for the year ending Whitsunday 1850,				25 0 0
June 1	To farm, received for 15 steers, sold at Edinburgh, at L.11,		165 0 0		
" "	By farm, paid for 20 steers, bought at Darlington, at L.6. 6s.,				126 0 0
" 9	To farm, received for 129 qrs. oats, sold Isaac Marshall & Son,				
	at 16s.,		96 0 0		
" "	By farm, paid clover and rye-grass seed account,				50 10 0
" "	By farm, paid turnip seed account for the year,				12 0 0
" "	By farm, paid for 10½ qrs. of beans, at 22s.,				11 2 9
" 15	To farm, received for 170 clipped hogs, at 30s.,		255 0 0		
" "	To farm, received from W. Barff for 118 stones wool, at 26s.,		153 4 0		
" 24	By farm, paid half-year's rent due at Whitsunday last,				500 0 0
July 1	By farm, paid William Young for use of his stallion,				1 2 6
" "	By farm, paid for 3 loads of paling, at 10s.,				1 10 0
Aug. 26	By farm, paid sundries, viz.—				
	Assessed taxes,	L.7 18 1			
	Income tax,	11 0 8½			
Sept. 27	To farm, received for 60 draft ewes, sold at St Ninian's fair, at 32s.,		96 0 0		18 18 9½
" 29	By farm, paid for 200 half-bred lambs, bought at Melrose, at 14s.,				140 0 0
" "	To farm, received for the carcass and skin of a heifer,		4 10 0		
" "	By B. L. Co.'s Bank, withdrew from them,		50 0 0		
" "	By balance on hand at this date,				40 2 7
			L.3559 18 4		L.3559 18 4

6410.

FARM-ACCOUNT—CROP 1849.

Dr.

Cr.

		Fol. of Ledger.	L. S. D.	L. S. D.
1849.				
Oct. 4	By cash for 60 qrs. wheat sold Isaac Marshall and Son, at 37s. 4d.,			112 0 0
" 11	By cash received from I. Marshall & Son, for 60 qrs. of oats,			48 0 0
" 17	To cash paid for 30 steers bought at Yarm, at L.7,		210 0 0	
" 24	To cash paid harvest expenses, as per abstract,		71 8 10	
" "	To cash paid for 5 sacks of oatmeal, at 2s.,		6 10 0	
Nov. 4	By cash received for 80 qrs. of oats sold to John Cloy, at 16s.,			64 0 0
" 11	To cash paid John Irons, for castings bought of him,		6 0 0	
" 11	By cash received from James Cuthbert for 35½ qrs. wheat, at 34s.,			59 14 3
" 20	To cash paid Phoenix Fire Office premium of insurance on stock and crop,			
			7 17 9	
Carry forward,			£301 16 7	£283 14 3

FARM-ACCOUNT—continued.

Dr.

Cr.

		Fol. of Ledger.	L. S. D.	L. S. D.
1849.	Brought forward,		301 16 7	283 14 3
Nov. 22	To cash paid labour account for half-year ending this day, as per abstract,		184 11 6½	
" "	To cash paid schoolmaster's stipend for year ending this day,		1 17 6	
" "	By cash received from the shepherd for fallen mutton,			1 15 0
Dec. 2	By cash received from Thomas Dewar for 80 qrs. oats, at 15s.,			62 0 0
" 25	By cash received from Timothy Wood for 40 wethers, at 34s.,			68 0 0
" 30	By cash received from Jacob Keyworth for 60 wethers, at 36s.,			108 0 0
" "	By cash received from John Newman for 50 qrs. barley, at 20s.,			50 0 0
1850				
Jan. 1	By cash received for 20 pigs sold in Edinburgh, at 30s.,			30 0 0
" "	To cash paid for 25 pigs bought in Berwick market, at 15s.,		18 15 0	
" "	To cash paid half-year's rent due Martinmas 1847,		500 0 0	
" 6	By cash received from James Marrowman for 24½ qrs. barley, at 19s. 6d.,			22 12 0
" 7	To cash paid ironmonger and others their accounts, as per cash-book,		24 18 2	
" 13	By James Marrowman for 31 qrs. wheat sold him, at 35s.,			54 5 0
" 27	By cash received from John Factor for 30 qrs. barley, at 18s.,			27 0 0
Feb. 3	By cash received from John Factor for 30 qrs. barley, at 18s. 6d.,			27 15 0
" 20	By cash received from Adam Butters for 15 steers, at L.18,			270 0 0
" "	To cash paid for 15 steers bought at Darlington, at L.7,		105 0 0	
" "	To cash paid James Cuthbert for 3 tons of oilcake, at L.8,		24 0 0	
" 24	By cash received from J. Cornbuey for 30 qrs. barley, at 19s.,			28 0 0
Mar. 15	By cash received for 100 wethers sold at Edinburgh, at 32s.,			160 0 0
" 17	To cash paid for 15 steers bought at Darlington, at L.8,		120 0 0	
" "	By cash received from John Cornbuey for 61 qrs. barley, at 20s.,			61 0 0
" 21	By cash received for 14 steers sold at Newcastle, at L.18,			252 0 0
Apr. 1	To cash paid the saddler's account for past year,		8 0 0	
" 14	By cash received for 120 wethers sold at Edinburgh, at 35s.,			210 0 0
" 22	To cash paid for lime bought at the Sunderland kilns,		9 5 3	
" "	To cash paid for 15 tons of guano, at L.9 per ton,		135 0 0	
" 25	By cash received from John Factor for wheat and barley, as per cash-book,			143 18 1
May 5	By Isaac Marshall and Son, for 20 qrs. of wheat at 37s.,			37 0 0
" "	By cash received for 48 pigs sold at Edinburgh, at 30s.,			72 0 0
" 8	By cash received for 16 steers sold at Newcastle, at L.14,			224 0 0
" 15	By cash received for 15 steers sold at Newcastle, at L.12,			180 0 0
" 26	To cash paid labour account for half-year ending this day, as per abstract,		130 7 0	
" "	By cash received from shepherd for fallen mutton,			6 15 0
" 28	To cash paid poor-rates for the year ending Whitsunday 1850,		25 0 0	
June 1	By cash received for 15 steers sold as Edinburgh, at L.11,			165 0 0
" "	To cash paid for 20 steers bought at Darlington, at L.6, 6s.,		126 0 0	
" 9	By cash received from Isaac Marshall & Son for 120 qrs. oats, at 16s.,			96 0 0
" "	To cash paid clover and ryegrass seed account,		50 10 0	
" "	To cash paid turnip-seed account for this year,		12 0 0	
" "	To cash paid for 10½ qrs. of beans, at 22s.,		11 2 9	
" 15	By cash received from William Barff and Sons, for 118 stones wool, at 26s.,			153 4 0
" "	By cash received for 170 clipped hogs, sold at 30s.,			255 0 0
" 24	To cash paid half-year's rent due at Whitsunday last,		500 0 0	
July 1	To cash paid William Young, for the use of his stallion,		1 2 6	
" "	To cash paid for three loads of paling, at 10s. per load,		1 10 0	
Aug. 26	To cash paid assessed and income taxes for year ending 6th April,		18 18 9½	
Sept. 27	By cash, received for 60 draft ewes sold at St Ninians fair, at 32s.,			96 0 0
" 29	To cash paid for 200 half-bred lambs bought at Melrose, at 14s.,		140 0 0	
" "	By cash received for the carcass and skin of a heifer,			4 10 0
" 30	By shepherd for ewes and hogs dead since Whitsunday, as per stock account,			2 15 0
			£2399 15 1	£3152 3 4

6411.

LEDGER.

Dr.

BRITISH LINEN COMPANY'S BANK.

Cr.

		Fol.	L. S. D.			Fol.	L. S. D.
1849.	To Balance from last year's account,		300 0 0	1849.	By Cash,		15 0 0
Oct. 1				Oct 17			
1850.				1850.			
Feb. 3	To Cash,		100 0 0	Jan. 1	By Cash,		230 0 0
Mar. 3	To Cash,		320 0 0	Sept. 29	By Cash,		50 0 0
" 23	To Cash,		200 0 0	" "	By Balance,		1125 0 0
Apr. 28	To Cash,		200 0 0				
May 8	To Cash,		300 0 0				
			£1420 0 0				£1420 0 0

LEDGER—continued.

Dr.

JAMES MARROWMAN, CURN-DEALER.

Cr.

Dr.		THOMAS BUTTERS, BUTCHER.		Cr.			
		Fol.	L. s. d.			Fol.	L. s. d.
1850. Oct. 1	To Balance of last year's account for wheat,		30 0 0	1849. Oct. 4	By Cash,		30 0 0
1850. Jan. 13	To Farm for wheat,		54 5 0	1850. Jan. 27	By Cash,		54 5 0
			£84 5 0				£84 5 0

Dr.		ISAAC MARSHALL & SON, MILLERS.		Cr.			
		Fol.	L. s. d.			Fol.	L. s. d.
1849. Oct. 1	To Balance of last year's account due for cattle,		45 0 0	1849. Oct. 4	By Cash,		45 0 0

Dr.		SHEPHERD.		Cr.			
		Fol.	L. s. d.			Fol.	L. s. d.
1850. Sept. 30	To Farm for fallen Mutton,		2 15 0				

6412. INVENTORY AND VALUATION OF STOCK AT 1st OCTOBER 1850.

The following is a List of the Effects in my possession, and of Debts due to and by me this 1st October 1850:—

I. CASH—		L. s. d.	L. s. d.
On hand,		40 2 7	
In open account with B. L. Co.'s bank,		1125 0 0	
			1165 2 7
II. IMPLEMENTS,			300 0 0
III. HORSES, 14 at L.25,			350 0 0
IV. CATTLE—			
1 Short-horn bull, at L.20,		20 0 0	
6 Short-horn cows, at L.12,		72 0 0	
15 calves, at L.5, 10s.,		82 10 0	
14 yearlings, at L.11,		154 0 0	
20 yearlings, at L.8,		160 0 0	
			488 10 0
V. SHEEP—			
200 Leicester breeding ewes, at 32s.,		320 0 0	
101 Leicester draft ewes and gimmers, at 30s.,		151 10 0	
297 Leicester hogs, at 20s.,		297 0 0	
200 Half-bred hogs, at 15s.,		150 0 0	
			918 10 0
VI. PIGS—			
3 sows, at 60s.,		9 0 0	
1 boar, at 60s.,		3 0 0	
32 pigs, at 22s.,		35 4 0	
			47 4 0
VII. CORN—			
50 acres of wheat, $3\frac{1}{2}$ qrs. per acre = 175 qrs., at 30s.,		262 10 0	
50 acres of barley, $4\frac{1}{2}$ qrs. per acre = 225 qrs., at 20s.,		225 0 0	
100 acres of oats $6\frac{1}{2}$ qrs. per acre = 600 qrs., at 16s.,		480 0 0	
			967 10 0
VIII. SEED AND LABOUR on 100 acres of turnips, at 70s. per acre,			350 0 0
IX. DEBTS DUE ME AS PER LEDGER—			
The shepherd,			2 15 0
			4589 11 7
X. I OWE TO MY LANDLORD—			
Half-year's rent due Martinmas 1849,		500 0 0	
Do. do. Whitsunday 1850,		500 0 0	
			1000 0 0
CAPITAL IN 1850,			3589 11 7
Do. 1849,			3173 0 0
Gain on crop 1849,			L.416 11 7

6413. *Remarks.*—When a sale is made for ready money, it is entered in the Cash-book as it occurs, and thence posted to the Farm-account. But when a delivery of any produce is made, which is not paid for in ready money, the transaction is entered in the Farm-account, and posted from it to an account which is then opened against the purchaser in the Ledger. When a payment, either to account or in full, is received from him, it is entered in the Cash-book, and posted from it to his credit in the Ledger. If the farmer had no transactions but ready-money ones, and no cash passing through his hands but in connection with his own business, a Cash-book alone would preserve a sufficient account of his year's proceedings. But as he will inevitably have cash transactions not *directly* connected with his business, as well as his family and personal expenditures, which should be duly entered; and as he may, from time to time, make both sales and purchases on credit, it is clear that a Cash-book *alone* would not give an accurate view of the real state of his affairs, or of the clear profit or loss on his year's farming; and, therefore, it is necessary to have a Farm-account, to show what is the real increase or deficit on the farm produce of the year, apart from all extraneous transactions; and a Ledger, to show what debts are due to the individual, and by whom, and for what.

6414. The Inventory and Valuation in (6412,) made up at the beginning of the agricultural year of 1850, are the counterpart of those in the beginning of 1849, (6408,) showing the state of affairs at the beginning of both years, by which it appears that a gain of £416, 11s. 7d. has been made upon the transactions of the year 1849-50, which is the sum the farmer has received as interest upon his capital, and remuneration for his labour. After deducting from this sum his outlay for family and personal expenditure, and adding it to his capital, the balance forms his starting-point for the following year's accounts. The family and personal expenditures are not given in detail, or at all, because they are wholly a private matter, and will vary according to the habits and views of the individuals interested in them. The clear income, therefore, derived from the business for one year is

only given, and no information is afforded as to its disposal.

6415. The rent is subdivided into a convenient form for the farmer. One half is paid in cash, and the other half by commutating an equal sum by an equivalent in quantity of grain, the value of which is estimated by the fiars prices (5292) for the crop and year. The equivalents in grain are taken in equal quantities of wheat, barley, and oats, at 144.665 quarters, because the fiars prices of Berwickshire, where the farm is situate, for crop 1849, were 35s. 0½d per quarter for wheat, 18s. 4½d. for barley, and 15s. 8½d. for oats, which give the amount of the half-year's rent at £500, the money-rent having been estimated, at the time of taking the farm, at £1000 a-year, or £2 per acre. To carry out the principle of paying the rent illustrated in (5292.) £500 have to be paid in money, and the other half by the value of the fiars; but as the farm was supposed to have been taken at the period when its first year's rents were payable for crop 1849, the second half of the £1000 had to be commuted into equivalent quantities of grain at the price of the fiars of 1849, which will be found to yield £500, at the fiars specified above, on 144 quarters and a fraction of each sort of grain. In future years £500 will have to be paid in cash at one term, and the value of 144 quarters of each sort of grain at their respective fiars prices for the year, at the other term, for each crop. The half of the rent will thus fluctuate with the value of the grain, and the other half remain stationary. The profit being £416, 11s. 7d., it indicates that the rent is a fair one to leave a reasonable percentage on a capital of £4173, shown in (6408) to be required to stock the farm.

6416. The young farmer is of course aware, that in book-keeping the Debtor column is always the left hand one, and the Creditor the right; and that the word "To" is prefixed to Dr. sums, and "By" to Cr. ones. But as he may be at a loss to understand why the same transaction appears in the Cash-book as a Dr. sum, and in the Farm-account, or Ledger, as a Cr. one, I offer the following explanation:—In the Cash-book, the *farmer*, or keeper of the books, is Dr. "To" all sums

received by him, and Cr. "By" all sums paid by him. In posting the books, however, when the various entries are carried to the Farm-account, or Ledger, as the case may be, these terms are reversed, for this reason—that in the Farm-account, the farm is accounting to the farmer for introductions on its special account, and is Cr. "By" all the sums which he has received for its produce, and Dr. "To" all the sums which he has paid on its account. And, in like manner, in the Ledger, each person with whom there have been credit transactions appears Dr. "To" the Cash-book, or Farm-account, for whatever cash or commodity has been paid or delivered to that person, and Cr. "By" whatever has been received from him.

6417. These make up the stated and indispensable books for an orderly system

of book-keeping; but the following subsidiary ones are so useful and instructive, that they should not be dispensed with.

6418. The farm is supposed to contain 500 acres (5367,) of arable land, divided into 20 equal-sized fields, and wrought in a five-course rotation, so that the

Fields A, B, C, and D, will be in turnips,
 .. E, F, G, and H, .. wheat and barley,
 .. I, K, L, and M, .. first year's grass,
 .. N, O, P, and Q, .. second year's grass,
 .. R, S, T, and U, .. oats.

6419. The corn-accounts show all the particulars connected with this species of produce, the time when thrashed, the parties to whom it has been sold, the uses which have been made of it on the farm during the year, the balance of grain on hand at any time in the corn-barn and granary, the weights of the grain, and the prices obtained for it.

6420.

CORN-ACCOUNT—CROP 1849.

		Whole Quantity.		WHEAT.	Weight per bushel.	Amount of Produce.				Disposal.				Rate.	Price.			
		Qrs.	Bu.			Clean.		Light.		Used.		Sold.			L.	S.	D.	
						Qrs.	Bu.	Qrs.	Bu.	Qrs.	Bo.	Qrs.	Bu.					
1849.																		
Oct. 3	To	62	..	Thrashed from field G, (stacks 9, 10, 11,)	64	60	5	1	3			60	..	37/4	112	0	0	
" 4	By	60	..	Sold Isaac Marshall & Son,														
" 4	To	21	3	Thrashed from field E, (stack 1,)	64	21	..	..	3								
" 6	By	23	3	Sown on field A, and part of B,						7	4							
Nov. 7	To	15	7	Thrashed from field E, (stack 2,)	64	20	4	..	4									
" "	By	36	7	Bruised for pigs,						1	6							
" 11	..	35	1	Sold to John Cuthbert,	63							35	1	34/	50	14	3	
1850.																		
Jan. 9	To	40	..	Thrashed from field E, (stacks 4 and 5,)	64	38	4	1	4			7	4					
" 10	By	7	4	Sown upon field B,														
" 13	..	32	4	Sold to J. Marrowman,	63							31	..	35/	54	5	0	
" "		31	..															
Apr. 25	To	62	3	Thrashed from field G, (stacks 6, 7, 8,)	64	60	..	2	3									
" 28	By	63	7	Sold to John Factor, (3 qrs. 7 bu. light,)									63	7	36/	116	3	1
" 30	To	20	7	Thrashed from field E, (stack 3,)	64	20	..	..	7								
May 5	By	20	..	Sold to Isaac Marshall & Son,									20	..	37/	37	0	0
" "		..	7	Bruised for pigs,						7								
						220	5	7	..	17	52	210	..		£379	2	4	
						7	..					17	5					
				Totals,		227	5					27	5					





6421.

CORN-ACCOUNT—CROP 1849.

		Whole Quantity.		BARLEY.	Weight per bushel.	Amount of Produce.				Disposal.				Rate.	Price.			
		Qrs.	Bu.			Clean.		Light.		Used.		Sold.			L.	S.	D.	
						Qrs.	Bu.	Qrs.	Bu.	Qrs.	Bu.	Qrs.	Bu.					
1849	Oct. 2	To	32	3														
	" 3	By	6	6		31	"	1	3	6								
			25	5														
Dec. 25	To		30	"		28	6	1	2									
	" 30	By	55	5														
			50	"	56						50	"	20/		50	0	0	
1850	Jan. 1	To	5	5														
	" "	By	29	"		28	"	1	"	6	6							
			34	5														
	" "		6	6														
	" "		27	7														
	" "		3	5														
	" 6	"	24	2	55						24	2	19/6		22	12	0	
	" 24	To	31	3														
	" 27	By	30	"	54													
	" 30	To	1	3														
			34	4		33	4	1	"									
Feb. 3	By		35	7														
			2	3														
	" "		33	4	56													
	" "		30	"														
	" 16	To	3	4														
	" "		14	"		13	4	"	4									
	" "		16	3		16	"	"	3									
	" 19	"	30	"		28	"	2	"									
	" 24	By	63	7	56													
			30	"														
Mar. 15	To		33	7														
	" 17	By	31	"		30	"	1	"	3	7							
	" "		64	7														
	" "		3	7														
	" "		61	"	56													
	" "		61	"														
	" 30	To	63	"														
	" "	By	6	6		60		3	"	6	6							
	" "		56	2														
April 14	"		9	2														
	" 25	"	47	"														
			9	4														
	" "		37	4														
	" "		3	"														
	" 28	"	34	4	56													
			27	6														
May 23	"		6	6														
			6	6														
						298	6	12	7	58	5	253	"		£244	12	0	
						311	5					58	5					

Totals,

6422.

CORN-ACCOUNT—CROP 1849.

		Whole Quantity.		OATS.	Weight per Bushel.	Amount of Produce.				Disposal.				Rate.	Price.
		Qrs.	Bu.			Clean.		Light.		Used.		Sold.			
						Qrs.	Bu.	Qrs.	Bu.	Qrs.	Bu.	Qrs.	Bu.		
1849.					lb.										
Oct. 15	To	65	7	Thrashed from field T., (stacks 31 and 32,)		55	10								
"	By	10	7	Used for horses,						10	7				
"	22	55	2	Thrashed from field T., (stacks 30 and 33,)		80	9	2							
"	By	144	6	Used for wages,						60	6				
"	"	83	4	Sold to Isaac Marshall & Son,	43							60	16/	43 0 0	
"	26	60	2	Used for horses,											
"	To	23	4	Thrashed from fields T. and U., (stack 34)		35	5								
"	To	40	"												
Nov. 1	"	63	4	Thrashed from field U., (stack 38),		39	4	5	4						
"	"	45	"												
"	4	108	4	Sold to J. Cloy,	42							80	16/	64 0 0	
"	By	80	"												
"	"	24	4	Used for horses,								20			
"	"	20	"												
Dec. 2	To	8	4	Thrashed from field U., (stacks 35, 36, and 37,)		110	13								
"	To	123	"												
"	By	131	4	Sold to Thomas Dewar,	42							80	15/	62 0 0	
"	By	80	"												
"	"	51	4	Used for horses,								19			
"	"	19	"												
1850	"	32	4	Used for horses,								20			
Jan. 30	"	20	"												
Feb. 7	To	12	4	Thrashed from field S., (stacks 23, 24, and 29,)		100	20								
"	To	120	"												
"	To	132	4	Thrashed from field R., (stack 27,)		40	3								
"	To	43	"												
Mar. 15	By	175	4	Used for horses,								30			
"	By	30	"												
"	"	145	4	Sown upon fields N. and P., (Sandy,)								30			
"	"	30	"												
"	"	115	4	Sown upon fields O and Q., (Potato,)								31			
"	"	31	"												
"	"	84	4	Used for horses,								9			
"	"	9	"												
April 30	"	75	4	Used for horses,								20			
"	"	20	"												
May 23	To	55	4	Thrashed from field S., (stack 28,)		35	6								
"	To	41	"												
"	By	96	4	Used for horses,								20			
"	By	20	"												
June 6	To	76	4	Thrashed from field R., (stacks 22, 25, and 26,)		120									
"	To	120	"												
"	By	196	4	Sold to Isaac Marshall & Son,	43		10					120	16/	96 0 0	
"	By	110	"												
"	"	86	4	In granaries for horses,								86	4		
"	"	86	4												
						614	4	82	5	357	1	340		£270 0 0	
						82	5					357	1		
Totals,						697	1					697	1		

6423.

AMOUNT OF PRODUCE—CROP 1849.

Kind of Crop.	Numbers of the Fields.	Size of Fields.			Average per Acre.		Amount of each Field.		Gross Amount.	
		A.	R.	P.	Qrs.	Bu.	Qrs.	Bu.	Qrs.	Bu.
Wheat, . . .	5	25	0	0	4	1 $\frac{1}{2}$ $\frac{5}{8}$	103	2	227	5
Do. . . .	7	25	0	0	4	7 $\frac{4}{8}$	124	3		
Barley, . . .	6	25	0	0	5	4 $\frac{3}{8}$ $\frac{5}{8}$	140	3	311	5
Do. . . .	8	25	0	0	6	6 $\frac{2}{8}$ $\frac{5}{8}$	171	2		
Oats,	17	25	0	0	6	4 $\frac{4}{8}$ $\frac{5}{8}$	163	0	687	1
Do.	18	25	0	0	6	3 $\frac{3}{8}$ $\frac{5}{8}$	161	0		
Do.	19	25	0	0	7	4 $\frac{3}{8}$ $\frac{5}{8}$	188	1		
Do.	20	25	0	0	7	0	175	0		
Acres in crop, .		200	0	0	6	0 $\frac{2}{8}$ $\frac{3}{8}$	..	..	1226	3

6424.

DISPOSAL—CROP 1849.

Acres in crop, 200 at a general average—

	Qrs.	Bu.		Qrs.	Bu.		Qrs.	Bu.
Per acre of 6 0 $\frac{2}{8}$ $\frac{3}{8}$							1226	3
Used in seed, of wheat, . . .				15	0			
.. of barley, . . .				18	6			
.. of oats, . . .				61	0	Qrs. Bu.		
						94	6	
Used in provender, of wheat, . . .				2	5			
.. of barley, . . .				12	7			
.. of oats, . . .				235	3			
						250	7	
Used in wages, of barley, . . .				27	0			
.. of oats, . . .				60	6			
						87	6	
							433	3
Leaving for sale,							793	0
Of this there are 210 of wheat, at the average price of £1 15 10 $\frac{3}{8}$	Qrs.							
.. 253 of barley, at the average price of 0 19 3 $\frac{4}{8}$								
.. 330 of oats, at the average price of 0 15 9								
Total, 793 at a gross average price of 1 2 2 $\frac{1}{8}$ $\frac{3}{8}$								
								£880 16 9

6425.

STACKYARD—CROP 1849.

1. Wheat. Field E.	2. Wheat. Field E.	3. Wheat. Field E.	4. Wheat. Field E.	5. Wheat. Field E.	6. Wheat. Field G.	7. Wheat. Field G.	8. Wheat. Field G.
9. Wheat. Field G.	10. Wheat. Field G.	11. Wheat. Field G.	12. Barley. Field F.	13. Barley. Field F.	14. Barley. Field F.	15. Barley. Field F.	16. Barley. Fields F & H. $\frac{1}{2}$ of each.
17. Barley. Field H.	18. Barley. Field H.	19. Barley. Field H.	20. Barley. Field H.	21. Barley. Field H.	22. Oats. Field R.	23. Oats. Field S.	24. Oats. Field S.
25. Oats. Field R.	26. Oats. Field R.	27. Oats. Field R.	28. Oats. Field S.	29. Oats. Field S.	30. Oats. Field T.	31. Oats. Field T.	32. Oats. Field T.
33. Oats. Field T.	34. Oats. Fields T & U. 2 Loads of U.	35. Oats. Field U.	36. Oats. Field U.	37. Oats. Field U.	38. Oats. Field U.		

REALISATION.

6426. The live stock accounts give, in numbers on hand at different periods, like manner, the particulars of every the prices obtained, and those paid for species of stock, the disposal of them, the them.

6427.

STOCK-ACCOUNT—1849.

		Whole No.	CATTLE.	Steers.	Cows.	Calves.	Price.	
							L. S. D.	L. S. D.
1849.								
Oct. 2	To	1	Bull,	1				
" "	"	6	Cows,		6			
" "	"	10	Steers rising 1 year old,	10				
" "	"	5	Heifers do.,		5			
" "	"	15	Steers rising 2 years old,	15				
		37		26				
" 10	"	30	Two year old steers bought at Yarm, at L.7,	30	11		210 0 0	
1850.		67		56				
Feb. 20	By	15	Steers sold Adam Butters, at L.18,	15				270 0 0
		52		41				
" "	To	15	Steers bought at Darlington, at L.7,	15			105 0 0	
		67		56				
March 20	"	15	Steers bought at Darlington, at L.8,	15			120 0 0	
		82		71				
" 21	By	14	Steers sold at Newcastle, at L.18,	14				252 0 0
		68		57				
May 8	"	16	Steers sold at Newcastle, at L.14,	16				224 0 0
		52		41				
" 15	"	15	Steers sold at Newcastle, at L.12,	15				180 0 0
		37		26				
June 1	"	15	Steers sold at Edinburgh, at L.11,	15				165 0 0
		22		11				
" "	To	20	Steers bought at Darlington, at L.6, 6s.,	20			126 0 0	
		42		31				
Sept. 29	By	1	Heifer died,		1			4 10 0
		41			10		£561 0 0	£1095 10 0
" "	To	15	Calves weaned,			15		
		56				10		
						31		
						56		

6428.

STOCK-ACCOUNT—1849.

		Whole No.	Pigs.	Breed- ing Pigs.	Feed- ing or store Pigs.	Rate.	Price.	
							L. S. D.	L. S. D.
1849.								
Oct. 2	To	3	Sows,	3				
" "	"	1	Boar,	1				
" "	"	20	Store pigs,		20			
		24		4				
Oct. 24	"	18	Weaned, (2 litters,)		18			
		42			38			
Nov. 7	"	8	Weaned,		8			
		50		46				
1850.	By	20	Sold at Edinburgh,	20	30/			30 0 0
		30		26				
" "	To	25	Bought at Berwick,	25	15/		18 15 0	
		55		51				
May 8	By	48	Sold at Edinburgh,	48	30/			72 0 0
		7		3				
June 8	To	30	Weaned, (3 litters,)	30				
		37		33				
		1		1				
		36		32				
				4			L.18 15 0	L.102 0 0
				36				

6429.

STOCK-ACCOUNT—1849.

		Whole No.	SHEEP.	Ewes.	Feed- ing Sheep.	Hoggs.	Rate.	Price.		
								L.	S.	D.
1849.										
Oct. 2	To	200	Ewes,	200						
" "	"	290	Hoggs,			290				
" "	"	320	Wethers,		320					
" "	"	3	Rams,		3					
Oct. 30	By	813			323					
		3	2 hoggs and 1 wether dead,		1	2				1 5 0
Nov. 30	"	810			322	288				0 10 0
		2	Hoggs dead,			2				
Dec. 25	"	808				286				
		40	Wethers sold to Timothy Wood,		40		34/			68 0 0
" 31	"	768			282					
		4	3 hoggs and 1 wether dead,		1	3				1 10 0
1850.										
Jan. 3	"	764			281	283				
		60	Wethers sold to Jacob Keyworth,		60		36/			108 0 0
" 30	"	704			221					
		3	Hoggs died,			3				1 10 0
Feb. 28	"	701				280				
		2	1 ewe and 1 hogg dead,	1		1				0 15 0
Mar. 15	"	699			199	279				
		100	Wethers sold at Edinburgh,			100	32/			160 0 0
" 30	"	599				121				
		3	2 ewes and 1 wether dead,		2	1				2 0 0
April 14	"	596			197	120				
		120	Wethers sold at Edinburgh,			120	35/			210 0 0
" 30	"	476								
		2	Hoggs dead,			2				1 0 0
May 30	"	474				277				
		3	2 ewes and 1 hogg dead,	2		1				1 0 0
June 15	"	471			195	276				
		170	Clipped hoggs sold at home,			170	30/			255 0 0
		301				106				
						195				
			<i>Account altered by addition of Lambs.</i>			301				
July 8	To	200	Breeding ewes and gimmers,	200						
" "	"	101	Draft ewes and gimmers,		101					
" "	"	170	Wether lambs weaned,			170				
" "	"	130	Ewe do. do.,			130				
Sept. 27	By	601				300				
		60	Draught ewes sold at St Ninian's fair,		60		32/			96 0 0
" 30	"	541			41					
		290	Half-bred wether lambs, bought at Melrose,			290	14/	140	0 0	
" "	By	741				500				
		3	Hoggs dead,			3				1 15 0
		738				497		£140	0 0	£908 5 0
						41				
						200				
						738				

6430. *Remarks.*—The quantity and value of live-stock on hand, at the end of one year, may vary so materially from that at the next, that the balance exhibited by the stock-book might give a most fallacious view of this department of the farmer's affairs; and therefore an

exact Inventory and Valuation of stock should be made up annually, and added to the summary of his balances and liabilities, and it will contribute to the exhibition of a true state of his affairs at the close of the year.

6431. Of the Labour-account concerning the field-workers, a few examples for one month will suffice to show how it is kept. The letters A, B, C, represent the

names of certain of the field-workers, the number of whom on this farm actually reaches to the letter P, as will be seen in the subsequent detailed account.

Week ending	A.						Wk. of days.	B.						Wk. of days.	C.						Wk. of days.
	M.	T.	W.	T.	F.	S.		M.	T.	W.	T.	F.	S.		M.	T.	W.	T.	F.	S.	
1849.																					
Oct. 6	1	1	1		1	1	5	1	1	1	1	1	6	1		1	1	1	4		
" 13		1	1	1	1	1	4	1		1	1	4	1	1	1	1	1	5			
" 20	1	1	1	1	1	1	6		1	1	1	4	1	1	1	1	1	5			
" 27	1				1	1	3	1	1		1	4		1	1		1	3			

6432. On an extension of this form of account, it affords the materials for a summary of the amount of all the manual labour executed on the farm in the course of a year, including the harvest expenses.

The gross amounts only of this account have been entered in the preceding books. With this account the system of book-keeping recommended concludes.

LABOUR ACCOUNT—MARTINMAS 1849.

Names.	No. of days.	Rate per day.	L. S. D.
A	72½	10d.	3 0 5
B	112½	10d.	4 13 9
C	19	10d.	0 15 10
D	105	10d.	4 7 6
E	108½	10d.	4 10 2½
F	111½	10d.	4 12 11
G	111½	10d.	4 13 1½
H	63	5d.	1 6 3
I	64½	5d.	1 6 19½
J	67½	10d.	2 16 5½
K	105	10d.	4 7 6
L	138	5d.	2 17 6
M	122½	5d.	2 11 0½
N	154	10d.	6 8 4
O	8½	10d.	0 7 1
P	10	1s. 3d.	0 12 6
			L.49 7 3½
Half-year's wages of 7 yearly ploughmen,			14 0 0
Groom's half-year's wage,			7 0 0
Foreman's do.,			6 0 0
Q, spadesman,	129½	2s.	12 19 0
R, do.,	129½	2s.	12 19 0
Blacksmith's account,			13 15 0
Joiner's do.,			11 7 6
Foreman's expenses,			2 3 9
Own incidental expenses,			5 0 0
			L.134 11 6½
<i>Harvest Expenses.</i>			
Wages,		L.48 17 4	
Bread,		11 5 6	
Beer,		11 6 0	
		L.71 8 10	

LABOUR ACCOUNT—WHITSUNDAY 1850.

Names.	No. of days.	Rate per day.	L. S. D.
A	{ 3	8d. }	1 7 7½
	{ 30½	10d. }	
B	{ 4½	8d. }	4 6 2½
	{ 70½	10d. }	
C	{ 6	8d. }	0 10
	{ 8	10d. }	
D	{ 38½	8d. }	4 7 11½
	{ 74½	10d. }	
E	{ 40½	8d. }	4 7 2½
	{ 72½	10d. }	
F	{ 43	8d. }	4 9 6
	{ 73	10d. }	
G	{ 3½	8d. }	4 5 5
	{ 71½	10d. }	
H	{ 43½	8d. }	3 4 8
	{ 43	10d. }	
I	{ 2½	8d. }	0 6 5½
	{ 5½	10d. }	
J	{ 5	8d. }	0 12 11
	{ 11½	10d. }	
K	152½	10d.	6 7 3½
L	160	10d.	6 13 0
M	64	10d.	2 13 4
N	1	10d.	0 0 10
O	11	8d.	0 7 4
P	12	8d.	0 8 0
			L.44 8 5
Half-year's wage of 7 yearly ploughmen,			14 0 8
Foreman's half-year's wage,			6 0 0
Groom's do.,			7 0 0
Q, spadesman,	117½	2s.	11 15 0
R, do.,	157	2s.	15 14 0
Blacksmith's account,			12 10 9
Joiner's do.,			8 9 6
Foreman's expenses,			5 9 4
Own incidental expenses,			5 0 0
			L.130 7 8

6433. Were the same accounts arranged in the form of Charge and Discharge, they would give a bird's-eye view of the amount of all the transactions of the year; and such a view may be engrossed on a single

page of any of the former books. Such a form not only classifies all the transactions of the year, but checks the accuracy of the total sums of the various accounts, and facilitates a correct balancing of accounts.

ACCOUNT OF CHARGE AND DISCHARGE OF THE INTROMISSIONS OF A— B—, FARMER
AT ———, FOR CROP AND YEAR ENDING 1st OCTOBER 1850.

6434.

DISCHARGE.

BRANCH I.—RENT, TAXES, AND INSURANCE.		L.	S.	D.	L.	S.	D.	L.	S.	D.
1850	1st. Rent—									
Jan. 24	By paid half-year's rent, due at Martinmas, . . .				500	0	9			
June 24	By do. due at Whitsunday, . . .				500	0	0			
1849	2d. Taxes—				1000	0	0			
Nov. 22	By Schoolmaster's stipend, for year ending this date, . . .	1	17	6						
1850										
May 23	By poor-rates for year, to Whitsunday 1850, . . .	25	0	0						
Aug. 26	By assessed taxes, . . .	7	18	1						
" "	By income-tax, . . .	11	0	8½						
1849	3d. Fire Insurance—				45	16	3½			
Nov. 20	By premium paid Phœnix, for one year, . . .				7	17	9			
								1053	14	0½
BRANCH II.—LIVE STOCK BOUGHT.										
" "	1st. Cattle—				561	0	0			
" "	Cattle bought, per stock account, . . .									
" "	2d. Sheep—				140	0	0			
" "	Sheep bought, per stock account, . . .									
" "	3d. Pigs—				18	15	0			
" "	Pigs bought, per stock account, . . .							719	15	0
BRANCH III.—FARM WORKING.										
1850	1st. Seed bought—				50	10	0			
June 9	By clover and grass seed account, . . .				12	0	0			
" "	By turnip-seed account, . . .				11	2	9			
" "	By 10½ qrs. of beans, at 22s., . . .									
1849	2d. Furnishings and Repairs—				6	0	0			
Nov. 7	By John Irons, for castings for mill, . . .				8	0	0			
1850	By ironmonger's account, for past year, . . .									
Jan. 7	By sundry accounts—									
" "	Farrier, . . . L.5 0 0									
" "	Roper, . . . 2 10 0									
" "	Mason, . . . 4 10 4									
" "	Slatcr, . . . 4 17 10									
Feb. 20	By 3 tons of cake from James Cuthbert, at L.8 per ton, . . .				24	0	0			
April 1	By saddler's account, for past year, . . .				8	0	0			
" 22	By lime, bought at Sunderland kilns, . . .				9	5	3			
July 1	By 15 tons of guano, at L.9 per ton, . . .				135	0	0			
" "	By 3 loads of palings, at 10s., . . .				1	10	0			
1849.	3d. Labour and Oatmeal—				208	13	5			
Oct. 27	By harvest expenses, . . .	71	8	10						
" "	By 5 sacks of oatmeal, at 26s., . . .	6	10	0						
Nov. 22	By Labour account for half-year to date, . . .	134	11	6½						
May 26	By do. do. do. do. . . .	130	7	8						
July 1	By William Young, for use of his stallion, . . .	1	2	6						
					344	0	6½			
								626	6	8½
BRANCH IV.—DEBTS DUE ME.										
1850	By shepherd, due me for fallen mutton, . . .							2	15	0
Sept. 30										
BRANCH V.—BALANCE.										
	Cash on hand, . . .				40	2	7			
	Balance at credit in account, with the British Linen Company, . . .				1125	0	0			
								1165	2	7
	Sum of discharge,							3567	13	4

6435.

CHARGE.

		L.	s.	D.	L.	s.	D.
BRANCH I.—Balance on hand at 31st October 1849—							
	Cash,	40	0	0			
	Balance in account with British Linen Bank,	300	0	0			
					340	0	0
BRANCH II.—Debts due me at 1st October 1849, per last account,					75	0	0
BRANCH III.—Corn sold—							
	Wheat sold, per corn account,	379	2	4			
	Barley do. do.	244	12	0			
	Oats do. do.	270	0	0			
					893	14	4
BRANCH IV.—Live stock sold—							
	1st. Cattle.						
	Cattle sold, per stock account,	1095	10	0			
	2d. Sheep.						
	Sheep sold, per stock account,	908	5	0			
	3d. Wool.						
	Wool sold, per farm account,	153	4	0			
	4d. Pigs.						
	Pigs sold, per stock account,	102	0	0			
					2258	19	0
Sum of charge,					L.3567	13	4

6436. The only remark I shall make on the plan of farm book-keeping, just particularised, is, that were a state of Charge and Discharge made out every year, the Farm-account might be dispensed with. That account distinctly points out, at any given period, the receipts from, and the expenditure on, the farm; but as such information may be desiderated only at the end of the year, the gross amounts of the different kinds of produce from the farm—constituting the heads of the various classes of expenditure inserted into the Charge and Discharge—seem all that is necessary to afford the information required.

6437. Every farmer ought to be provided with a pocket Memorandum-book, in which should be written down every transaction as it occurs, according to its date, whether connected with cash or not, and from which the particulars should be

posted in the proper book. Without such a memorandum, confusion may not only ensue in the larger transactions of the farm, but promises verbally given may be broken, and inconvenience arise to parties from forgetfulness and neglect. At one time, it was customary in farmers to trust solely to the memory to record their transactions, and I have heard extraordinary instances of accuracy in persons who transacted business of the most multifarious character by memory alone; nevertheless, the safer plan for the farmer is to jot down every particular that involves, in the least degree, the interests of others besides his own.

6438. A simple form of keeping the Field-workers' Daily Labour-account is the following; and I take the particulars from the Labour-account exemplified in (6431) for the month of October:—

A. Oct.	||||.|||	|.||||.	|||||||	||. . . ||	= 18 days, at 10d., £0 15 0
B. ...	|||||||	|. . . ||	|||||||	||| . . ||	= 19 ... at 10d., 0 15 10
C. ...	|.||||.	|||||||	||||. . |	. . . ||	= 16 ... at 10d., 0 13 4

The explanation requisite is, that between the long strokes are comprehended the days of a week. The short strokes are the full days' work done by the fieldworker; the dot is the day in which she is not at work; and when a quarter, or half, or three-quarter day is only wrought for, the figure of a $\frac{1}{4}$, $\frac{1}{2}$, or $\frac{3}{4}$ is substituted for a short stroke or dot, as the case may be.

By placing the name of the month in the line of the strokes when it arrives, the four weeks in each month will be easily discerned, as also the days of each week. The account thus kept for half-a-year, the days are summed up and calculated at the rate of wages per day, and the gross amount of half-year's earnings are brought out as distinctly as in the example

in the Labour Account above. In this manner the accounts of a large number of field-workers may be kept by the steward in a small book.

CONCLUDING EXHORTATIONS TO THE
YOUNG FARMER.

6439. When the young farmer is completely settled on his farm, he voluntarily undertakes certain duties and obligations which he must perform and fulfil. A simple relation of these may prove useful to him.

6440. It is a paramount duty of every farmer of an arable farm to have his field operations in an advanced state at all seasons. He should remember that, if by forgetfulness or delay any important operation is postponed for even a week beyond its most proper season, it may not only be overtaken by the succeeding bad weather, but he thereby invites a deficient crop. When his field operations are in advance of the season, it is in his power to wait a few days at any time for the land to be in the best possible state; and when every operation is finished with the land in that condition, he may cherish the well-founded hope of a good return.

6441. For the attainment of this advancement of labour, the working stock which the farmer possesses should be fully adequate to undertake every field operation in its most proper season; for, independently of the reasonableness of this requirement, he should remember that delays may be imposed upon him to an indefinite extent by bad weather; and the time thus lost can never be made up should those means be inadequate, but which may easily be made up when the work is in advance, simply by waiting the lost time.

6442. That his means of labour may at all times be most efficiently employed, and then they will also be most economically employed—the farmer should have the ingenuity to arrange each department of his labourers so as not only to receive from them the largest amount of labour, in a given time, but also the largest amount when the different classes of labourers cooperate. For example, when the ploughs

are working separately, and when the field-workers are working separately, they should do their respective works efficiently; but when ploughmen and field-workers are employed in the same work—when manual and mechanical labour are combined—the relative strength of each should be proportioned to produce the greatest amount of combined labour in a given time.

6443. As one great means of obtaining full and efficient work, the farmer should have his horses in the best order: they should be well selected, equally matched, sufficiently fed, properly groomed, and judiciously wrought; and when so treated they will be willing and able to do their work, they will do a large amount of work, and they will be in good health to perform it at all seasons.

6444. As a concurrent means to the same end, the farmer should select active, willing, strong, honest, and skilful labourers. With such ploughmen he will have his horses well driven, and the land well wrought; and with such field-workers the lighter and more minute parts of work will be neatly and quickly executed.

6445. As a still further means to the same end, the farmer should select the best-constructed implements of each class; for, how little soever the effects of good and bad implements may be appreciable at any given time, he may depend upon it that, with implements constructed on the most correct mechanical principles, the labourers will not only make the best work, but the horses will use them with the greatest ease to themselves.

6446. The ploughmen, horses, implements, and field-workers, may be regarded as the working stock of a farm; and unless they are all maintained in the most efficient state, the farmer cannot expect his field operations to be executed in the best manner.

6447. Besides the land, the farmer should bestow much of his solicitude on the welfare of his live-stock. In winter, he should be satisfied that those confined in the stabling have abundance of food, are comfortably lodged, and carefully tended, and those abroad in the fields

are provided with sufficient food. It is of much importance to the wellbeing of stock, whether in the steading or in the field, that the turnips be always in the most proper state; and that, although frost should ensue, sufficiency of them are stored for the emergency. In summer, too, the pasturing of grass fields requires his attention, as much for the sake of the pasture itself, that it be neither too much nor too little eaten down; as for the stock, that they never be injured by an insufficiency of food and water; and the same degree of attention is requisite when the stock are soiled on green forage.

6448. As long as the grain market continues active in winter, the farmer should attend to the thrashing and the cleaning of the grain, for the double purpose of supplying his stock with a sufficiency of straw, whether of fodder or of litter, and of disposing of the grain while the market is in an active state. It is not safe for a farmer to speculate on his own grain in the straw; for, if he retain it in the stack, the live-stock suffer from the want of fodder and litter, and the land suffers from the want of manure; and if he thrash it faster than the stock can consume its straw, this suffers deterioration in quality both as fodder and litter, and also as manure. It should be the farmer's endeavour to clean his grain for the market to a perfect state, and to acquire in the grain market he attends the character of a clean dresser of grain; for in that state alone, let him be assured, grain weighs heaviest and commands the highest price.

6449. The farmer should endeavour to dispose of his fat stock at home. If he has earned for himself the character of a good breeder and feeder, and of being always desirous of disposing of his extra stock at home, purchasers will regard it no trouble to come and inspect them, and make a bargain. The driving of stock to a market-stance has a certain depreciating effect upon their appearance, besides the expense and trouble of doing it, and the depriving them of food for a number of hours. The exhibition of stock at a market implies either the acceptance of the market price, whatever that may be, or the driving them home again—in which latter case the character of the stock

suffers, and advantage is taken of this by future purchasers.

6450. These particulars constitute the ordinary routine experienced on an arable farm of mixed husbandry. The farmer, however, ought never to be satisfied with ordinary routine, and the Scottish farmer seldom is. He should constantly be making experiments on a limited scale, both in raising the plants of the field and in rearing and feeding live-stock; and although no great effect may have been derived from any one experiment, they not only serve as beacons, to warn him from proceeding in his ordinary practice in one direction, but as incentives to prosecute them still further in another. Let the farmer never fail to try every experiment suggested, the object and importance of which have been sufficiently explained to him. He may much more safely follow such suggestions than adopt the recommended practices, of an unreasonable nature, of non-practical men. For example, when the farmer is told that cattle thrive better when lodged on bare deal boards than on comfortable straw, and that they are more healthy on such boards, with their urine and dung exposed below and behind them, even although under the process of deodorisation, than when these are absorbed and hidden in the straw, let him not believe it; because he knows that when he is himself comfortably lodged, he is better in every respect than in a contrary situation. He may probably be recommended to cut all his straw into chaff, for the purpose of giving the whole of it in fodder to his live-stock, with the view of increasing the size of his farmyard dung-heap. Let him not give ear to such persuasion; because, if Liebig be correct in his views of the mode by which the animal heat of the body is maintained, no less than 60 per cent of the carbon of the straw will be breathed away in carbonic acid gas into the air. When he is told that it is better, in every respect, for sheep to be tied by the neck in a house than at freedom in the open air, let him give no credence to it, because he knows that confinement and restraint are quite contrary to the nature and habits of that animal. When liquid manure is so strongly recommended to him, that, in order to obtain it, the

cattle must be confined in byres instead of hammels, let him doubt the propriety of the recommendation, because he knows that it has been ascertained by chemistry, that the urine is the more valuable portion of the evacuations of every animal, and that, when it is separated from the dung, the latter is deteriorated in value in that proportion, and that the urine itself, unless scientifically managed, will lose a large proportion of its ammonia—the most valuable of its ingredients. When cattle are recommended to be confined within the limits of a box which will deprive them of any exercise, that they may fatten the quicker, instead of being in a small hammel, where they may have moderate exercise if they choose, let him receive the recommendation with caution, because he is aware that the laying on of fat is not the only object in feeding cattle—the paramount object being the laying on of large masses of flesh; and when he knows that the animals he breeds are come of a kind having a strong disposition to fatten, they will find no difficulty in acquiring a sufficiency of fat, provided they lay on abundance of flesh. It is well known that the taste of the consumer for *fat* meat has much altered within the last twenty years. Then, colliers could not obtain too fat mutton; now, they won't purchase it: then it was supposed that beef could not be made too fat; now oxen fetch the highest price, in the London market, which afford the largest and deepest cuts of flesh along the back. It is therefore a retrograde movement to desire, now-a-days, to put on additional fat by depriving animals of exercise. The object of the farmer should rather be to increase the disposition to fatten in his stock, by carefully following the principles of superior breeding, than to contrive restrictive measures to put fat upon ill-bred stock. Of the three modes of feeding oxen—the byre, the box, and the small hammel—experiment has already proved the superiority of the hammel over the byre, and no experiment has yet proved that of the box over the small hammel; no farmyard manure has yet been produced superior to that obtained from small hammels. Warmth, not heat, is favourable to laying on both flesh and fat; and the small hammel, provided with abundance of straw, affords the requisite quantity of warmth and shelter, if one may judge

from the conduct of the cattle when in them. When farmyard manure is recommended to be wholly applied to the soil in a liquid form, let the farmer doubt the propriety of the expedient, because, although he is aware that plants take their food in the liquid form, he also knows that every cereal and green crop will only take as much food as it requires at any given time—and he does not yet know at what period of its growth it is disposed to take the largest proportion of food; and he knows besides that, if more moisture is presented to a plant than it wants, the surplus quantity will rather injure than promote its growth. Moreover, it is quite possible that the surplus moisture may enter into such combinations with the constituents of the soil, as to form compounds injurious to the particular state of the plant, when the dissolved manure happens to be applied. The recommendation is as yet wholly unsupported by experience. It is probable that the manure in the liquid state would always form a good top-dressing to grass land, but its safe applicability to ploughed land is attended with reasonable doubt, especially in a moist climate.

6451. When the farmer is told by the scientific man that the nutritive principle of the plants he raises—the nitrogen—is chiefly derived from the ammonia which was first produced by decomposition of animal matter in the soil, then taken up in the air by its lightness, and sent back into the ground by means of rain and snow, let him doubt the efficacy of such a process to sustain his crops, even although it should have Liebig's great name in support of it; because he knows that the very careful experiments of Frezenius only detected 0.133 of a part of ammonia, out of 100,000 parts of air; and he also knows by experience, that the wheat he cultivates thrives best in dry weather, provided the heat be not excessive, and that in all wet seasons it is not so good in nutritive properties as in dry—neither of which results ought to accrue if the nitrogen of plants be derived from the air alone, as is stated to be the case. Chemistry informs him, besides, that wheat requires the most ammonia of any crop he cultivates, and that the farmyard manure supplies as

much of it as wheat requires; and, therefore, there seems no necessity at least for crops to receive their ammonia in the roundabout way described. If he is told that the carbon of his crops is principally, if not wholly, derived from the atmosphere, and that all he has to do is to supply, by mineral manures through the soil, the mineral ingredients required by the particular plant he wishes to cultivate, as Liebig hastily recommended, let him doubt it, because careful experiments have rendered it probable that some of the carbon of farmyard manure is taken up as food by plants independently of that existing in the atmosphere. If any one specific manure is recommended to him as being necessary for any particular plant, let him receive it with doubt, because researches into the composition of plants have shown a difference in the constituents of the same plant when grown in different situations, or fed with different manures. We do not yet know how far those variations may be carried, but the fact that they are considerable is established. At all events, plants are not dependent on one sort of food for their growth and development.

6452. On the other hand, when a practical man recommends a plan of pulverising strong clay in preparation for turnips, by rolling the ground when a little dried on the surface after being ploughed, and then harrowing it after the rolling instead of before, the farmer may safely follow the practice, because it not only stands to reason, but the difficult object of pulverising strong clay in dry weather is said to be thereby attained. When a veterinary surgeon recommends the giving only a small quantity of milk at a time, and frequently, to a new-dropped calf, until it is a week or ten days old, the farmer may believe him, because he knows that calves are not seldom afflicted with indigestion when young; and he may deem it extremely probable, when told so, that the indigestion is superinduced by giving the young calf large quantities of milk at a time, without a due proportion of saliva, contrary to the small quantities which it takes from its mother, when allowed to suck her, and the large quantity of saliva which it discharges in the act of sucking. An active motion of the jaws

thus seems requisite for calves when drinking their milk. When he is recommended to single Swedish and white turnip, though not the yellow, at 13 or 14 inches apart—instead of 9 or 10 inches, the usual distance—he may reasonably try the experiment, because he knows that turnips are plants which require both room and air, and the smaller number of plants upon the acre may each attain to much greater size, from the quantity of manure usually given to the acre, and produce a greater weight than the larger number of plants of smaller size. If sheep are recommended to be experimented on for fattening in preference to cattle, because their size allows them to be more easily weighed—their smallness requiring less quantity of food, and their numbers affording facility in subdividing them into lots, each of which may contain a considerable number, among which the idiosyncrasy of any particular sheep could not affect the results of the experiment so sensibly as one ox in a small lot—he may adopt the suggestion at once, because he discerns truth to be contained in these differences between the two kinds of stock. And lastly, not to multiply instances, when he is told that cabbages, or any other plant containing much nitrogen, is good food for sheep, the wool of which it is desirable to increase, the statement may be believed, because he knows that the wool contains $13\frac{1}{2}$ per cent of nitrogen, whereas the flesh only contains $3\frac{1}{2}$ per cent. In short, the judging between reasonable and unreasonable practices is easily acquired, when the farmer takes time to consider the nature of plants and of animals, and the peculiar idiosyncrasy which each exhibits.

6453. In his bearing to his own people, the farmer should always show them kindness; and if he ever have to change his conduct towards them, it should be from some fault of theirs, not his. He should not find fault continually, as constant rebuke produces no reformation, but rather indifference. A fault should generally be checked; but those arising from the head, and not the heart, should be gently dealt with. Theft and falsehood should never be pardoned, and the delinquent should be got rid of at the end of the term of service. Such a step is necessary, for checking the

spread of moral contamination. When a ploughman is seen to quarrel seriously with his horses, the safest expedient for both man and horses is to cause him to unloosen them from the yoke, and put them into the stable until the next day, when his temper will have calmed down. Even severe rebuke at the time, with allowance to continue at work, will never convince him that he was wrong and the horses were right, although that is the more probable state of the case. The wives and children of married men are frequently troublesome about a farm. Whenever it is seen that a man cannot control his own household, he should be parted with at the expiry of the term. Much more work will be obtained from field-workers by kindness than by severity.

6454. The farmer ought to be punctual in his payments to his servants at the specified terms. He who neglects to pay them regularly loses control over them, and actually places himself in their power in many ways. Workpeople calculate on laying out their earnings when they become due; and on their being withheld at the period of expectation, the disappointment is far greater than they choose to exhibit. Women feel disappointment acutely.

6455. In his relation to his neighbours the farmer should be most punctual to his engagements. If he has promised to buy or sell any commodity with a person on a given day, he should faithfully keep his appointment. If he has promised to settle accounts with any one on a given time, he should do so without fail. A very few breaches of promises will attach an unenviable reputation to his name in the part of the country in which he resides, and a few more such may entirely ruin his credit.

6456. Above all, the farmer ought to be punctual in the payment of his rent to his landlord, because it is by agreement with him that he is in the position of a tenant at all. In treating for terms of payment on negotiating for the lease, they should be fixed at Candlemas, in the beginning of February, and at Lammas, in the beginning of August. For the settlement of the Candlemas rent

he should dispose of as much of the grain as will make up the sum with the balance in his Bank book; and at Lammas the sum is easily made up by the sale of cattle, sheep, and wool, besides grain. It is safe practice for a tenant, whenever one rent is paid, to provide immediately for the succeeding one; and he should always remember that the payments to the servants, and of accounts, are made at the intermediate terms between those of the rent.

6457. The farmer should provide recreation and instruction at home. Recreation he may find in his own family, and occasionally in visits with and from friends at a distance, and neighbours at hand; and for instruction he must have recourse to books and papers, and partly to the converse of friends and strangers. If he provide not these attractions at home, he will go where they are to be found, and neglect the concerns of his farm. It is a common remark by townspeople that farmers, as a class, are averse to reading. If they knew the habits of farmers as well as I do, the observation, even if strictly true, would be no obloquy. Little do townspeople know the weight of fatigue which early rising and constant exercise in the fields on foot—which the farmer is obliged to take in summer, who has improving operations to superintend—impose, and of the lassitude which overtakes the frame when resting in the evening after the fatigues of the day. It is then physically impossible for any man to betake to reading a subject that requires thought and reflection, or any subject at all. The desultory newspaper affords the most fitting literature to his mind until the hour of bed, which must be early. No one has a higher relish for reading than myself, and yet I have seen a whole summer slip away without having read anything but the newspapers. In winter it is different, and in that season it is not true that the farmer does not read—for many read much, and as a farmer advances in years and takes less exercise, his leisure is greatly devoted to reading. We have only to peruse the discussions in the Farmers' Clubs in England and at the monthly meetings of the Highland and Agricultural Society in Edinburgh, to be satisfied that the present race of farmers read and have read to good purpose. Townspeople believe

that the artisans of towns are more intelligent than the labourers of the country. I have had many opportunities of conversing on miscellaneous subjects with both classes of workpeople, and never could observe the superior intelligence of the town artisan. I am sure the grocers' shopman does not know the countries from whence the various articles he deals in come, nor the processes by which the articles are prepared for the market, except, it may be, the art of adulteration. The journeyman cabinetmaker knows as little of the countries which supply the different kinds of ornamental wood. It is the same with other trades. The country labourer is at least observant of every thing around him: he knows the weather, different kinds of soil, different kinds of rock, different kinds of trees, the habits of plants and animals; and can discriminate individual character very shrewdly. The intelligence of the manufacturer, too, is often placed in favourable contrast with that of the farmer; and the usual example of superiority is adduced in the manufacturer availing himself immediately of every improved piece of machinery, while the farmer is represented as neglecting similar opportunities for improvement in his business. The cases are not at all analogous. The manufacturer knows, with certainty, that the machinery which will suit a similar manufacture to his own at one place, will suit his purpose also; but the farmer has no certainty of an implement suiting a district of the country altogether dissimilar to his own in climate, soil, situation, and locality, answering his own. He prudently waits the approval of others before he adopts it in his own business, which is always materially affected in its results by the slightest change of the elements. I would put the cases of the manufacturers and farmers of this kingdom in this way: The British manufacturer is situated in the most favourable circumstances for the prosecution of his business, with coal, machinery, conveyances, and sea-ports,—the British farmer is not, in regard to soil and climate. The foreign manufacturer is not placed, in those respects, in the most favourable circumstances for the prosecution of his business—the foreign farmer is.

And yet the foreign manufacturer is equal to the production of marketable goods to the British manufacturer; while it is acknowledged, on all hands, that the British farmer is superior in every respect to the foreign farmer, in what relates to the cultivation of the soil and the rearing of live-stock. In comparison, therefore, with foreign compeers, the British farmer stands in a much higher position than the British manufacturer.

6458. In catering for his mental food, the young farmer should not neglect to take the periodicals connected with the great Agricultural Societies of the kingdom. The best works on agricultural chemistry and physiology, both animal and vegetable, should not be neglected. His own local newspaper he of course always patronises; and I think that he should procure, besides, a London agricultural newspaper, on account of the fulness of the reports of the numerous markets of the kingdom, as well as foreign ones, which they always contain.

6459. In conclusion, I would exhort the young farmer to maintain that independence of mind and judgment, which is not only honourable and becoming, but a positive duty to the very important class of which he is a member. Let him never forget that he belongs to a profession which has been recognised, by those best entitled to form an opinion on the subject, as contributing in no small degree to the maintenance of the constitution and liberties of these islands; and that he is bound by every means in his power, whenever the occasion may present itself, to discharge the functions of a loyal British subject. In parting with the young farmer, I do not know that I can better conclude than by exhorting him to maintain in his own person, and in his own sphere, the high, manly, and independent character which for centuries has been acknowledged as the attribute of the British agriculturist. And with an anxious and heartfelt hope that my labours may prove profitable and instructive to some of my younger brethren, and be considered by the more experienced as tending to illustrate the science of agricultural economy, I conclude my task.

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APPENDIX TO AUTUMN.

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In our Northern States, Autumn is the most uniformly delightful period of the whole year. August is generally too warm for enjoyment, the mildness of Spring is treacherous, and the heat of Summer oppressive; but in September the weather begins to moderate, and in October and the early part of November we gradually pass into one of the most charming climates that can be found, or even imagined, in any quarter of the globe. The temperature is neither too cold nor too warm; it is neither the biting frost of winter, nor the melting heat of summer, yet the air is inspiriting and bracing.

Week often succeeds week of clear, mild weather; the air has not that brilliancy which we perceive at other seasons, but is pervaded by a softer glow; ripe fruit tempts one on every side, the full barns are odorous of hay, and the golden ears of Indian corn show themselves from among their loosened husks; all speaks distinctly of plenty and peace.

After frosts have commenced, and cold chilling wintry winds have already prevailed, we usually experience a return of mild weather for two or three weeks; this period has been called the Indian summer. The sudden coming of our frosts changes the color of leaves in a remarkable degree. If the early frosts are too severe, the change takes place at once, and the colors are consequently somewhat uniform; but when they begin gently, only a few of the more sensitive trees are at first touched.

Thus, here and there, on an autumnal morning, we see the brilliant scarlet hue of a maple, brightening the skirts or shining from the depths of yet unchanged verdure. Frost after frost succeeds, shade after shade starts out from the living tints of the forest, until at last all is one glowing field of mingled yellow and red, with faint, expiring traces of green. The richness of those broad masses of intense color is beyond all description.

Yet there is always a tinge of melancholy thrown over autumnal scenes; for all these mellowed and softened hues, these various ripened crops, these bare stubble fields, remind us, in the silent but certain evidences

which they present, of the approach of Nature's annual death, of our own uncertain tenure here, and of the inevitable fate that will sooner or later overtake all mortal forms of beauty.

The altered verdure, the quiet fall of the leaf, the gathering of birds for their southern flight, a thousand nameless sights and sounds, tell us that the season of life and vigor in the material world has passed—that sleep, death, and decay are at hand.

This is especially apparent in the forest; those tints, often so brilliant, are not the hues of life, but of incipient decay. The leaves no longer absorb carbonic acid, the sun's rays have lost their power to vivify, to cause the internal decomposition and recomposition which once went on so vigorously under their influence. We feel, as the leaves begin silently to wing their way with every breath of air towards the earth, that the tree has ceased to respire, that the functions of its external parts have for a time, at least, ended, and that we shall soon again see its bare arms tossing athwart a wintry sky.

Of Pulling Flax and Hemp.—This is the first autumnal operation to which Mr. Stephens has called our attention, that is particularly connected with American agriculture. His directions under this head will be found of much value. I have already said that little flax is now grown for any purpose in the New England States. Almost all that is grown in the Western States, and in New York, is with the object of obtaining the seed. The stems are left to decay, or are added to the soil again as manure. If the manufacture of flax would pay, it might be an object to water-rot the stalks as here described, but it is doubtful if it would prove at present so profitable as other crops. The two objects of growing good seed and fine flax, at the same time, cannot be attained; one is always perfected at the expense of the other.

4442. I have before alluded to the difference between dew-rotted and water-rotted hemp. There is no doubt but that hemp rotted by the latter process yields, when the operation is carefully conducted, by far the most valuable product.

The great difference in the market price of the best water-rotted and the best dew-rotted hemp, is a sufficient proof of this fact.

The better qualities of dew-rotted hemp are now brought into use for cordage, and for other purposes to which it was not formerly applied, and the demand has consequently increased. It is said by some growers that keeping the hemp in stack for much beyond the usual time, before rotting, improves its quality. A large portion of the dew-rotted hemp is injured by exposure on dirty, soft ground, whereby it becomes stained and discolored; the strength and smoothness of the fibre are also much injured. It is this careless way of rotting, involving little trouble, that induces many farmers to prefer the dew-rotting to the water-rotting process. They unquestionably save themselves some labor; but at the same time, as is almost invariably the case in such calculations, they lose money.

Many large planters are now water-rotting with great success, and by careful attention to the various steps of the process, others may also succeed. The universal testimony of cultivators seems to be, that hemp is not by any means a highly exhausting crop, particularly when compared with flax, and this is an additional incentive to its cultivation.

In many parts of the country a large portion of these crops is lost, by the faulty method of cutting adopted. In place of pulling, or cutting with a hook or scythe that can be laid flat upon the surface, many cut their crop with a cradle, or otherwise, at a height of several inches from the ground; thus, at the same time, they lose a large portion of their crop, and reduce its length of fibre.

Hemp is considered in Kentucky, and adjoining States, our great hemp-growing region, as a highly profitable crop, and the various statistical returns show that its culture is increasing from year to year.

It may seem to require some explanation, that I have omitted any mention of hops. Their cultivation is so limited, that little is said of hops as a crop in any of our statistical reports. There are, in fact, very few districts where the cultivation assumes a distinct form. So far as my information extends, in the absence of all reliable and authentic estimates, the culture is almost entirely confined to small patches in gardens, &c. From such a desultory mode it results, that the cured hops are usually inferior to the English in their quality. The crop being considered of little importance, not only is it neglected during its growth, but the requisite facilities for drying, &c., are not provided.

4459. *Of Cutting and Harvesting Wheat, Barley, Oats, Rye, and Indian Corn.*—Our whole system of harvesting grain in this country differs from that of Britain in many ways. The cradle-scythe here almost uni-

versally supersedes the sickle. Excepting in some limited districts, where emigrants from Europe cling to their old customs, the sickle is only used when grain has lodged so badly that the cradle-scythe cannot be swung freely, and will not lay the straw straight. Even in such cases, many farmers prefer to cut the lodged portion of their fields with the ordinary scythe, and to carry in the grain without binding, treating it as common hay.

The various systematic methods here described, in 4470 and succeeding paragraphs, might, in modified forms, often be of advantage to us in this country. Owing to a want of forethought in arrangement, much harvest work is done at a great disadvantage so far as regards economy of time and labor. Such rules would apply more particularly to large farms, although at the same time small farmers may glean many useful suggestions for their own practice.

Our climate is so fine that farmers do not always, as in England, at once follow up the cutting grain by binding. In many sections, indeed, they prefer, if the weather be settled, to let the grain lie in the swath for even twenty-four hours before binding. Where there are large weeds among the straw, this is almost indispensable, as also when the grain is cut quite green. If it is ripe and free from weeds, a common practice is for the men to cut a large piece in the morning and bind it in the afternoon.

The cradle scythe used here differs considerably from the implement known by that name abroad, and shown in fig. 399. The snath is of a better form than either fig. 399 or fig. 400, and the fingers extend almost to the point of the scythe blade. Our curved snath is so adapted to its work, that the cradler can stand almost upright, and yet lay the blade of the scythe so as to cut parallel with the surface. The upper end of the snath also has a curve, so that it revolves easily in the left hand, and enables the mower to turn up the cradle easily and gracefully, and deposit the cut portion of grain quite smooth and even. In good hands this American cradle makes beautiful work, and rapid work too; for if the grain is not extremely heavy, a strong man can strike forward a great portion of its length at every cut. In very heavy grain I should think that shorter fingers, a medium between the English and American fashions, might be an advantage.

There is, however, much bad cutting with the cradle scythe. A careless or unpractised mower is apt to *strike in high* and *point out high*, so that the stubble is left in ridges. I have seen fields where a very large portion of the straw was thus lost. It may be replied that this straw is of use on the land where it remains, and this is quite true; but the same straw taken to the yards, there used as

fodder and bedding, and returned in a partially decomposed state, mingled with animal manures, would have been of far greater value.

It is objected to our cradle scythes by some foreign authorities, that they are too heavy; but this is more in appearance than in fact, for their weight is found to be no difficulty in practice. The fingers being made of tough, dry wood, are much lighter than would be supposed. The motion in cutting is slow and measured, and the weight is just about sufficient to swing through the grain without any very powerful exertion on the part of the cradler. Many workmen prefer eradling grain to mowing grass, and consider it less fatiguing work.

As is the case with haying so with harvesting in this country, there are few farmers who hire their hands in companies; the greater number employ them by the day, depending on chance comers for any extra pressure of work. The practice of engaging one or two men to cut by the acre is gaining ground, and will be found most economical. Sometimes the cutters contract to bind the grain also, but more frequently this is done by the owner.

The sheaf gauge, fig. 397, is I believe an unknown instrument in this country, as I have never seen or heard of one in use. In most cases there is no rule as to size, other than the preferences of each individual binder. When grain is green and weedy the bundles are of course made small, as also when the straw is short and light in the swath; but generally they are made nearly as large as the straw will bind. The steward with his gauge, then, would find abundant employment in an American harvest field. Any great inequality in the sheaves is doubtless an evil, when it is desired to calculate the quantity of grain per acre by their number; but apart from this, I believe that in our dry climate no practical harm results from it. In England it would not answer at all, because the sheaves would not dry equally: but here, where difficulty in drying and storing grain is an exceptional case, there seems to be no necessity for such extraordinary precaution in this respect.

There is, however, one practical difficulty connected with the large sheaves which binders are tempted to make when the crop is heavy and the straw long; such sheaves cannot be so readily and quickly handled, and are very apt to break in pitching from the cart.

The remarks of Mr. Stephens as to the cutting of grain before it is fully ripe, par. 4463 to 4466, deserve careful attention, and I cannot return to this subject too frequently. They are now supported in this country by the experience of many careful farmers.

The writers in our agricultural papers also

generally give, as the result of their experience, a decided preference to the system of cutting every variety of grain before it has become entirely ripe. Some varieties may be profitably cut soon after the seed is fairly glazed. It is not only the grain that is rendered heavier, but the straw is also worth more, being green and better fitted for fodder. This is because it contains much matter in the form of sugar, gum, &c., which would in a few days more, in the natural process of ripening, have been converted for the most part into indigestible woody fibre.

The remarks upon the harvesting of maize, commencing at paragraph 4673, do not give the mode of treatment now adopted by our best farmers. It is a perfectly well ascertained fact that the best practice is to cut maize or Indian corn, early and close to the root, and to allow it to remain for some weeks in the field.

The old system was to top the stalks as soon as the grain had glazed, but this is now only pursued by those who have little faith in papers or books, and obstinately refuse to entertain novelties. Numerous experiments have proved most conclusively, that it is even better to allow the grain and whole stalk to ripen together in the field, until it is time to house the grain for the winter. In the May No. of the American Farmer, published at Baltimore, are detailed some experiments by, as I believe, that well known writer, Mr. E. Ruffin, which are entirely satisfactory upon the comparison between these two modes. The cutting of the whole stalk, however, soon after the grain has glazed, affords still more satisfactory results. The yield of corn per acre is larger, and also the weight per bushel is increased. The stooks are made three or four feet in diameter at the bottom, with the stalks pretty well spread. A band is passed around the top so as to make a rather solid point to the cone. Put up in this way, the air has free access to the thick butts and the ears, these being the parts that need drying. They stand in the field for several weeks, and then the corn is either husked on the ground or in the barn, as may be most convenient.

The stalks come out green and sweet, and as I have already had occasion to mention, are of much value for fodder, being eagerly eaten by stock, and considered by many excellent farmers as nearly equal to the best hay.

In view then of all these supposed advantages, every farmer should give the cutting system a fair trial; not carelessly and doubtfully, but fairly and candidly. The weight of all evidence on the subject being most strongly against the old topping plan, that at least should be discarded entirely, and a decision made between ripening on the entire stalk, or cutting the whole and ripening in the stook. If the statements that I have made

here and previously concerning the latter mode are true, and I believe that they cannot be successfully questioned, the controversy between these two methods cannot last long.

An exception must perhaps be made, of some very large cultivators at the south and west, who count their hundreds of acres of maize. There where labor is high, and grain cheap, and fodder not of much consequence, the cutting system would probably be too expensive; the best way for them at present being the cheapest. At the east there is, in my judgment, no longer a question as to the proper course in harvesting and curing this crop.

Our other grains are treated at first in much the same way as in England; that is, the sheaves are set up in stooks. After standing in this way for a day or two, they are, if the weather is good, ready for the barn. In case of bad weather, six, eight, or any convenient number of stooks that may be near together, are built into a small stack, arranged on the top to shed water as completely as possible. When the rain is over, a few hours of warm sun and wind will usually dry off the water, and render the sheaves fit for earthing. It is seldom, indeed, that well managed grain is injured by growing in the ear.

The custom of raking the stubble, so universal in Europe, is quite unknown on many farms. The usual practice is for the binder to carry with his rake the loose straws which have fallen in binding the last sheaf, forward to the yet unranked swath. Where one man rakes and others bind, much grain is left on the field, and going over it with a horse rake or large hand rake would pay well; in fact many farmers now make this a regular practice. We have yet no class corresponding to the gleaners of Europe, for there are none in our agricultural districts capable of labor, but can gain a subsistence in some more profitable manner.

The information given in par. 4531, as to the quantity of straw left in the form of stubble on cutting at different heights, will be studied with interest, and may well form a basis for farther experiments.

The points touched in paragraphs 4532 to 4554, are also interesting; the most important is relative to thin sowing and dibbling; the facts given under these heads are instructive, and may, now that the wheat drill is coming into use among us, be considered of much practical importance.

Mr. Stephens devotes but three or four paragraphs, 4568 to 4572, to the subject of reaping machines, showing that their use in Great Britain must be quite limited. It is so here also in most of our Eastern States, but in the West they have become to the farmer an auxiliary of the most powerful character. In the broad, unbroken, smooth fields of the

West, these machines find their natural sphere of action. At first these reapers were imperfect in principle and too slight in construction, so that breakages and interruptions of every kind almost neutralized their advantages. The various practical difficulties have within a few years been wholly or partially overcome by different makers, so that the use of such machines is becoming almost universal.

I do not consider myself called upon to decide as to the merits of the numerous reapers that are now offered to the public by different individuals. Judging from the testimonials that they exhibit, and the patronage that they receive, some of them possess great merit, and unite durability with efficiency in a most remarkable degree. A good reaper must not only be made upon a proper principle for cutting the grain evenly and rapidly, but it must be made as light as is consistent with durability; it should also have as few parts as possible, and these easily repaired or replaced; the cutter should not be readily dulled, or if dulled should be easily sharpened; it should also accommodate itself as far as practicable to inequalities of surface, and not miss any grain from such a cause even when proceeding quite rapidly. It is not easy to unite all these requisites, but still, according to the testimony of our western farmers, it has been done by some of the makers.

There are some reapers intended only to cut the heads from the grain, and leave the straw on the field. They are said to work well and rapidly, but it seems to me that the waste of grain must be great, especially if the straw is at all uneven in length. Such a reaper belongs only to a new country, where high farming is not considered practicable. Straw is a chief element in the calculations of every farmer who intends to keep his land up by the use of manure; and it is quite clear that after the trampling of men and horses, and the passage of wagons and machinery, it cannot be cut and collected with any advantage, but must for the most part lie on the field, to embarrass the plough, or to be wasted in a great degree by decomposition in the open air. It is not then probable that such a machine will continue in use when farming improves in its general character.

It is said by those who have had much experience, that a good reaper cuts cleaner, and makes less waste of grain, than the ordinary cradle or scythe.

I do not see that the corn and hay frames, shown by figs 405, 6, 7, and 8, differ greatly from some of those commonly used in this country, while we have also a great variety of other plans. It is usual when such a frame as fig. 405 is employed, to have an upright ladder rising from the front of the frame. This furnishes an easy means of ascent and

descent when the wagon is loaded, and a convenient place for the driver to hang his reins while he is engaged in loading. It adds little to the weight, and often proves extremely useful.

We never see in this country, or at least very seldom see, the straw rope, par. 4700. I have occasionally noticed a foreigner making one to carry a bundle of hay or straw, and think that their introduction might be of some advantage, as being cheap and quite effective for many temporary purposes where we are obliged to employ quite expensive materials.

Paragraphs 4619 to 4659 give a particular account of the manner of building and covering stacks, which will be very interesting to all who store their grain in this way. I have often noticed that the stacks of grain and hay in England and Scotland when opened show no marks of the penetration of rain, and have seen those in which grain had been kept perfectly sound and good for several years. In fact they consider that the only danger in keeping a crop over is, that rats and mice may obtain access to the interior; it is with a desire to avoid their visits that the stack shown in fig. 420 is elevated on stone posts. Kept in this way, grain is not near so much exposed to vermin as in a close barn, and I do not doubt that, as wood becomes dear, our farmers will ultimately have to resort to the stack as a cheap and efficacious method of preserving their crops.

Of the Birds Destructive to Grain Crops.—I have no doubt but the great majority of our birds are of far more advantage than disadvantage to the farmer, inasmuch as the insects injurious to vegetation that they are constantly destroying, far more than counterbalance the small quantity of grain that they may devour in autumn. Each pair of birds require, as food for themselves and young, thousands upon thousands of slugs, worms, bugs, and caterpillars, in the course of each season. It is probable that without their incessant activity, we should be entirely overrun by many classes of insects, which even now become sometimes too numerous for our comfort. It does not seem to me unreasonable that these little laborers should have their share, when it ripens, of the crop they have aided to protect. It is true that certain varieties in particular localities, sometimes become so numerous as to be very destructive, and to require active measures for the diminution of their numbers; but these are exceptions. As a general rule, the farmer who allows them to take their share, is not perceptibly poorer in purse; while at the same time he is, if he have a soul for natural melody and beauty, constantly delighted by the warbling notes and graceful flight of these seemingly happiest of all God's creatures. I do not envy the spirit of the man who on a soft vernal morning,

with the joyous flutter and song of birds around and above him, can think only of the few grains of corn that each will snatch from his fields, and occupy himself in coolly plotting their destruction.

There are times, however, when self-defence becomes necessary, and then the advocate of the feathered tribes must occasionally withdraw for a period from the defence of his favorites. Almost the only bird that is generally destructive to sown grain is the crow. He is particularly partial to Indian corn, but can generally be kept away without much difficulty by well arranged scarecrows. His organs of caution and cunning are more largely developed than those of the British rook. So extremely cautious is he, in fact, that he may frequently be made to overreach himself. A few hundred yards of cotton twine, running from the end of one pole to another about and across the fields, are usually quite as effective as more elaborate means of protection, for the crow suspects them to be connected with nets. I think they become sooner familiar with more alarming looking scarecrows, than with these simple things. The rook battery, fig. 425, would undoubtedly frighten crows, but it could not last longer than the first *Fourth of July*, for the farmer's boys would undoubtedly seize upon it as fabricated with an especial view to the celebration of that anniversary, and the cannon might mostly be reported unfit for service before night.

On the Management of Sheep in Autumn.—Paragraphs 4715 to 4787. There are some points under this caption that will be new, and many that will be interesting, to our sheep farmers and breeders. The directions as to the selection of both ewes and bucks are clear, concise, and full. Such judicious weeding of flocks as is here indicated, would lead in a few years to a wonderful change through many of our sheep districts.

As to bucks,—the enormous prices now annually obtained by some of the best English breeders (as the Messrs. Webb, for instance), for the services of their bucks during a single season, show what may be done in that line by care and judicious management. The farmers of this country are now fast coming to appreciate improved stock, and here they have one of the roads to improvement marked out for them. I have already mentioned the various methods of clipping sheep in baths, to free them from vermin, ticks, &c., also the different materials in use for this purpose. Smearing with tar and butter, or any salves of that nature, is almost unknown on this side of the Atlantic, but still finds occasionally an advocate.

From the remarks of Mr. Stephens upon its inutility, and the positive injury which results to the fleece from the practice, it is to be

hoped that our farmers will generally continue their ignorance or disapproval of such a custom. Shelter and food are doubtless a better protection than any smearing can be, and besides this, preserve the wool in fine condition. Bratting, or covering the body of the sheep with a species of jacket, might possibly be advisable in some bleak mountain districts; but our farmers generally, in the Northern States, rely on good warm barns and sheds for the protection of their flocks. There can be nothing gained by keeping them out in the fields when the ground is frozen from one to two feet in depth, and when no food is attainable except in the barn. This is one of the cases where climate has a controlling influence on the expediency of a practice.

I do not pretend to add anything to the descriptions and directions here given, as to the foot rot and other diseases, particularly as the references to standard works on the subject are very full. I have previously said that various diseases which are most fatal among the sheep of Great Britain, are not much dreaded here; some writers even go so far as to assert that they have never known a well authenticated case of the fatal disease called foot rot in England and Scotland. It may be that from the general inferior condition of our sheep, they are not so liable to inflammatory diseases as those that are habitually kept in higher flesh. It is also probable that the superior dryness of the climate has much influence.

The English modes of treating diseases are objected to by American farmers as too expensive. In districts where sheep are worth in summer only from \$1.20 to \$2 a head, it would obviously not pay to cut and bandage their feet daily for any length of time, still less to furnish them with a pair of boots, as recommended by some continental authors.

Mr. Randal, in writing of the *hoof-ail*, a disease sometimes very fatal, says "that *thoroughly* paring the feet, and then applying a solution of blue vitriol, is an unfailing remedy." All depends upon the completeness of the paring, and the care taken that every affected part is reached by the vitriol solution. In order to accomplish this effectually, he recommends the employment of a tub, containing about four inches of solution, as hot as it can be borne. In this the feet of the sheep just finished are placed, and it is forced to remain there while the next in order is under the knife and nippers, thus enabling the hot liquid to saturate every portion of the foot. Several years of following up such a course are required to eradicate this disease. The labor, however, is comparatively small the second year, and very little by the third.

Another method which has been found quite beneficial, is to drive the flock slowly through a trough containing freshly slaked

lime and water. This repeated once a week during warm weather, is said to check and gradually eradicate the disease. A ley of wood ashes also tends to its ultimate though not immediate cure.

The various diseases of sheep in this country have been fully treated of by Mr. H. S. Randall, in his letters on Sheep Husbandry, and in Morrell's American Shepherd. Youatt also has been published, and is now within the reach of American sheep breeders.

Of Lifting and Storing Potatoes.—Paragraph 4788. My remarks under the head of planting potatoes, will have been sufficient to show that the use of the plough in lifting them must be quite limited. This implement can only be employed successfully where the rows are perfectly straight and regular, and such rows do not exist in by any means the majority of our fields. Thus it has happened that ploughs when tried have been soon discarded, owing to the necessary imperfection of their work. A plough, with a grating somewhat similar to that shown in fig. 342, has been occasionally employed.

Until within a few years, and even now on a great number of farms, the potatoes are *dug* with a hoe, an implement which is of all others least fitted for the purpose. The whole body of earth in the hill must be moved, and a large hole excavated in search of stray tubers. During this operation many potatoes are necessarily cut, unless the workman begins entirely on the outside of the hill and works very carefully. This implement then, as I conceive, should now be abandoned as entirely unfit for the lifting of potatoes. Another and much more convenient one is rapidly replacing it—this is the potatoe hook. This tool is light yet strong, and does its work cleanly and rapidly. The hill can be completely and rapidly explored in every direction, without removing much of its surface. It is I think a far superior implement to the potatoe graip, fig. 433, being lighter, at least equally efficient, and making much easier work.

I am not aware that a riddle for separating the different sizes of potatoes is ever used in our fields; it is however the practice to separate by hand the small, cut, or otherwise unmarketable potatoes, from the others, with the view of using them for feeding purposes early in the season. Some farmers now select the small ones more especially for seed, with the idea that they make a less luxuriant growth, and are therefore less easily affected by the potatoe disease. This may be correct, but I have not known of any confirmatory experiments that were entirely satisfactory.

In the potatoe fields of this country we again miss the women, who seem to be so useful in Scotland, with their baskets in hand following close after the diggers. Our men have to do

this part of the business themselves, but as a recompense they probably find a more carefully ordered house, and a greater variety of food, awaiting their return home.

It may be well for our farmers to study attentively the various methods of pitting potatoes, described under this head. The directions here given will explain their numerous failures in attempts to keep potatoes by pitting. Many have seemed to think that the term pitting must signify an excavation, and have according buried potatoes or other root crops in deep holes, sunk far below the surface. Unless in peculiar situations, and under the influence of either natural or artificial drainage, such pitting must always prove more or less disastrous.

It will be noticed, that the requisites for keeping are, first—good drainage, managed as shown in fig. 435, then a smooth, solid covering sufficient to withstand the effects of frost, and lastly, provision for ventilation by a species of straw chimney, shown at 1 and 2 in fig. 435.

The usual method in this country is to store them in cellars; these should be cool, dark, and dry. To insure the latter point, they ought to be carefully drained. When the formation of the ground will permit, a large cellar under the floor of the barn or granary is very convenient. The temperature should not be readily affected by fluctuations in the temperature of the outer air.

I shall follow Mr. Stephens in saying little as to that most fruitful subject, the potatoe disease. At best we can only present theories as to its cause and cure. The principles of treatment mentioned in par. 4838 are doubtless correct; rich manuring with farm-yard manures is disadvantageous, but inorganic manures have been frequently, though not universally, of much service.

Of Sowing Autumn Wheat.—Par. 4842. The use of the drill for sowing wheat is rapidly increasing among us, and has in almost all cases given much satisfaction. There are many who hold out against it, and some that consider it worse than useless, but their number is decreasing. The deep sowing of the drill is a great advantage in all land where wheat is apt to winter kill; in fact, on such land, even those farmers who despise the drill, have had to take up the practice of ploughing in their seed to get it deep enough.

In many of the Eastern States, where wheat was once largely grown, its culture has greatly decreased; and in some districts scarcely any is to be found, excepting an occasional small patch of spring wheat. It is common to ascribe this to the Hessian fly, to the prevalence of rust, &c., &c.; but after we have made all due allowance for these causes of uncertain produce, the principal reason in my judgment is to be found in the deterioration

of the land. A good crop of wheat cannot be obtained by a stinted use of poor manure, or by imperfect cultivation; under such disadvantages, except on naturally rich, mellow, and unexhausted land, the plant refuses to produce freely. The farmer soon discovers that by the same treatment he can get better crops of rye, or oats, or Indian corn, and wheat is consequently superseded. Doubtless it is, in many Eastern localities, profitable to neglect this crop at present and buy cheap Western flour; but the time may, and probably will come, when the Eastern farmer can compete more advantageously in this respect, and I maintain that then, by proper manuring and proper cultivation, he will be able to grow larger crops of wheat than the land ever before produced.

Nibbling of wheat, as I have already mentioned, is now impracticable in this country at a profit. Seed wheat is cheap, and labor high, thus exactly reversing the conditions found in British agriculture. In the West particularly, the use of the drill will soon become very general, and with the aid in harvesting of the reapers now made so effective, the farmers can sow a greater breadth of land than ever before.

4783 to 4878. The results given here seem very favorable to thin sowing, but they cannot be looked for in all situations. Plants will not tiller much on poor, ill-manured soils, so that those who attempt to grow wheat on such soils, need not hope to save seed and increase their crop, by reducing the quantity sown. Even if the plant should tiller under such circumstances, by aid of plaster or some slight top-dressing, the effect would not be ultimately good, for its already feeble energies would only be subdivided among a number of shoots, none of which could produce large, well filled ears.

On the Effects of Special Manures.—Paragraphs 4904 to 5021. The information here collected is of a most valuable character, and may in fact be called a treatise by itself. There are as yet comparatively few men in this country who can appreciate the importance of the information here given, but their number is daily increasing. Guano, however, and bones, must in our husbandry still be considered special manures, although they seem to have lost that distinction in Scotland. The latter especially has been shamefully neglected, and the consequence of such neglect will be long felt over the whole length and breadth of our country, in the years of labor and expense which will be required to restore to the soil those elements of fertility of which it has been so constantly and improvidently robbed. It is probably speaking within bounds to say, that nine tenths of the bones that might be available for agricultural purposes in this country are entirely lost so far as they

are useful in their application to the soil. They are to a certain extent collected for the purposes of various manufactures, and for making glue; but only here and there a farmer is discovering that they are of any value to him. Their great efficacy when dissolved in sulphuric acid, is to the masses almost unknown.

So it is with even more active and concentrated manures; in our cities, by our road sides, by our manufactories, and even in our very barn yards, substances are suffered to lie neglected and to run to waste, which would fertilize thousands upon thousands of acres of poor, worn-out land, that is now scarcely worth inclosing. This waste was not felt when the land was yet rich and fresh, but now it begins to tell, and we must arrest it as speedily as possible.

In reading over the article at present referred to, the names and properties of many most valuable manures will be found noticed, and what is of no less importance, their action upon particular crops is shown. It will be seen that in many cases the most astonishing results have been obtained, by the addition per acre of what seems a very trifling quantity of some fertilizer. The simple explanation of such an increase is to be found in the fact that this addition has supplied just what the crop needs; of other substances there was an abundance before; but now the plant finds *all* that it wants, and grows with un wonted luxuriance.

The only explanation of the system pursued by many of our farmers, must be found in the fact that they do not understand the effect of cropping upon the soil; they do not understand that even when everything that is possible of that which grows upon a farm is returned to it, there is still a gradual exhaustion going on. No matter how carefully a farm may be managed, if anything whatever is sold off, a fresh supply of fertilizing materials from foreign sources will after a time become necessary. Thus, whether it is grain, or stock, or hay, or dairy produce, that goes off, a deterioration is proceeding more or less rapidly. It is in the supply of such a deterioration, that special manures are so effective. A particular class of substances has been slowly disappearing, and the manures added have only returned a part of these, they being but a part of the original produce; at last, this class becomes so reduced that the quality of the soil is visibly inferior. Now is the time when a manure composed of the particular substances which are most exhausted, will have a marked and immediate effect. So far are many of our farmers from comprehending this plain reasoning, that some of them can scarcely understand why it is that land constantly cropped should become poor, even when no manure at all is added. To such

farmers the list of special manures given in paragraph 4974 will appear perfectly ridiculous, and the high prices annexed to some of them quite absurd.

It is not very surprising, however, that much ignorance yet prevails among us on these subjects, when we find that even in Great Britain, with all the long list of fertilizers before us, all the accounts of their action, and all the writings of their distinguished men, there is even yet a waste of valuable manures that is quite enormous. Scarcely a beginning has been made even there in rendering available the stores of valuable materials which are swept through the sewers of their cities into the rivers, and into the sea. The subject is comparatively a new one in the best farmed regions of the world, but it is now presented in so many ways to our farmers, that they have no excuse for remaining any longer un-informed.

It is too often the case, that in commencing the use of these manures a great mistake is made. If a good effect is found to result from any particular application, the farmer is tempted to repeat it to the neglect of other manures. Thus great mischief has actually been done by the injudicious use of lime and also of plaster. The farmer finds a remarkable increase of his crop by adding a small quantity of one of them; they are cheap, and he repeats the dose, and perhaps goes on in this way for several years, not considering that he is supplying at most but two or three of the substances that the plants need, while he is abstracting large quantities of all. When the land gives out again, as it is quite sure sooner or later to do, the fault is not with the lime or the plaster, but with the cultivator, who has added only a part when he should have kept up the supply of all. It may seem an absurdity to lay down such a rule, but still it is one not so generally understood and observed as it ought to be. The principle that we cannot continue land in a state of fertility by adding one, two, or even half a dozen substances, while we are at the same time constantly taking away ten or twelve, would seem to be self-evident; and yet every man who has eyes may see it disregarded, by travelling a few miles in any direction.

He may not only see this, but he may find cases where all of his reasoning on the subject, and all of his efforts to show the suicidal nature of such a procedure, will be met with the most utter indifference, if not with supreme contempt. It is in fact a general observation which will soon be made by those who attempt to introduce improvements in this or any other department of agriculture, that those who know the least of their profession are most conceited, and most inaccessible to all reason. When we find a man who gets fifteen or twenty bushels of corn, five or

six of rye, and half to three quarters of a ton of hay, to the acre, whose fences are all down, whose cattle half starved, whose scanty store of manure is draining into the nearest brook, there is precisely the individual who will declaim upon the superiority of the good old method of practical education for farmers, when the nonsense of these book farmers had not yet been written. If Mr. Stephens could have added to his list of special manures, something adapted to cause a healthy growth of ideas in such minds, he would have done an infinite service to every agricultural district in the world, for specimens of this class may, unfortunately, be found in every country.

On Electro-Culture.—Paragraphs 5022 to 5033. This is a subject as yet little understood, even by scientific men; but at the same time it is gradually assuming a degree of importance which quite justifies Mr. Stephens in noticing it in a work of the present scope. I am inclined to think that electro-culture, as here described, has in most cases proved unsatisfactory, and yet there have been occasional results that cannot be entirely explained away. They seem sufficient to show that electricity does, under certain circumstances, exert a very decisive influence; but as to the laws by which that influence may be applied and regulated, we are yet much in the dark.

Attention is considerably drawn at the present time, both in this country and Europe, to the precise manner in which electricity acts upon the growth of plants. That it has under certain circumstances an effect, was shown so far back as the time of Sir Humphrey Davy, and perhaps at an even earlier period. It does not seem necessary to cite any experiments here in addition to the results collected by Mr. Stephens; they are sufficient of themselves to awaken an interest in the subject. Dr. Vaughan, of Cincinnati, has for several years been writing upon the influence of electricity in the flowing of the sap, and the assimilation of carbon, &c., in the interior of the plant; many of his papers have been published in Buchanan's *Journal of Man, Cincinnati, Ohio*. More recently an able article, by M. Becquerel, has appeared in the "*Annales de Chimie et de Physique*," Jan. No., 1851. He concludes that there are constant currents of electricity in the cells of the plant. He says, "The direction of the terrestrial currents shows, that in the progress of vegetation the earth constantly takes an excess of positive electricity, the parenchyma of the bark and the leaves an excess of negative electricity, which is transmitted to the air by the water evaporated."

The opposite electrical states of plants and of the earth, as he concludes, give rise to these currents, which opposite states are, as I sup-

pose, first brought on by certain chemical actions in the plant.

The pursuit of investigations on these subjects, will probably lead to most interesting practical results. The present *wire system* will, it is to be hoped, be succeeded by something more practicable and more certain in its mode of operation.

5034. *The Rationale of the Application of Special Manures.*—I will, under this caption, only add a few words to what I have already written upon this subject, in immediate connexion with the application of special manures. It seems to me dangerous to let the view of Liebig, with regard to the formation of ammonia in the soil, as given in pp. 5025 and 5036, go forth without at least some further qualification. A portion of the ammonia of plants may have been formed in the soil in the manner indicated by Liebig, but it does not from this follow that plants obtain all their nitrogen in the form of ammonia, or that it is not absolutely necessary to add nitrogenous manures to the soil, or to guard carefully against their deterioration while in the yard or heap. The inference drawn by Mr. Stephens in par. 5036 is a natural one if the premises are true; but apart from all theoretical reasoning, every day's practical experience shows us that the soil does not ordinarily contain enough of nitrogen-affording substances, and that it is immediately and strikingly benefited by their addition. The farmer who preserves his manures most carefully, and conducts their decomposition in such a manner as to suffer the least loss of ammonia, finds himself repaid in their increased efficacy when they are added to the soil. This whole theory is but one of the extreme views which Liebig has held upon some most important points in practice—views which he himself has repeatedly been led to change entirely, or to modify in essential features.

His great reputation, and the fascination of genius shown in all of his writings, have led to the enthusiastic adoption of his successive theories with regard to ammonia, and the consequent disappointment attendant upon their reduction to practice, has often produced a corresponding degree of distrust in the whole system of scientific agriculture.

The views of Mulder upon this subject of the formation of ammonia in the soil, paragraphs 5037 and 5038, are extremely beautiful, not inferior in this respect to those of Liebig. They are purely theoretical, but in my opinion lead us an important step towards the true understanding of this matter. They moreover agree with many of the important changes which have been observed to occur on the addition of pure vegetable matter to the soil. It does seem to me that by uniting these views, to a certain extent, with those of

Liebig, and admitting, as I am disposed to do, that plants may obtain their nitrogen in part from still other combinations, such as the nitrates for example, we arrive at conclusions which practice will strengthen rather than contradict. The great danger with purely scientific men is in attempting to simplify too much. The temptation is strong to make all if possible bend to one clear and beautiful theory, and so simplify until every operation can be clearly explained. It is seldom that this can be really done; the changes of decomposition and recomposition, of living to dead matter, and of decay to new life, are complex and varied, and cannot be represented by any one formula or series of transpositions.

The effect of every failure in the reasoning of distinguished scientific men is unfortunate in its effect on the progress of improvement, for the reason that it leads practical men into a general distrust of all theoretical views and recommendations. It is therefore of importance that novel theories should not at first be announced, or least should be qualified in such a manner, that their application to practice might not lead, in the first place, to too sanguine expectations, and finally to serious loss and disappointment.

5080. This is a subject (the Rotation of Crops), upon which the American farmer can as yet communicate comparatively little knowledge. On a vast number, I think it is fair to say on a vast *majority*, of farms a thorough and enlightened system of rotation is unknown. In many cases, even in the oldest States, the only system followed is to take the most valuable crop until the land runs down too low to bear it profitably. The best farmers are no doubt turning their attention in this direction, and we see much land that is so judiciously managed as to improve under cropping. There are more, however, who would be greatly benefited by a careful and attentive study of such an article as Mr. Stephens has here given us.

The fact noticed in par. 5082, as to the exhaustion of the land by grass crops when they are allowed to ripen their seeds, will doubtless be new to numbers who consider themselves in the main good farmers. In many parts of the State of New York and of other States, as I have before mentioned, it is customary to allow the timothy grass to ripen before cutting. The hay is poorer in quality under this system, and meadows so mown every year soon show its exhausting effects.

The general principles upon which the necessity of rotation in cropping depends, are clearly and sufficiently shown in this article, and the various courses instanced will be found instructive examples. Some of the crops are such as we do not cultivate, and we should have to introduce others that are

not mentioned here; but the value of the illustration remains the same, and any farmer in studying these plans will derive useful hints as to the management of his own soil, with the great ends of profit and improvement in view.

The excretory theory of De Candolle, par. 5106, is now considered as quite untenable, nevertheless I am inclined to think that plants do without doubt excrete certain substances from their roots in a state of solution; that these substances, however, are thrown off because they are injurious to the plant, I have no idea. They may have entered in combination with something which the plant more particularly required, and in such quantity as to produce an excess, and they may return to the soil for the purpose of forming new combinations, and perhaps once more entering the same plant. It is supposed that potash and soda circulate in this way, and convey to the plant its silica, and perhaps other substances which singly are insoluble, but which readily dissolve when combined with either of these alkalis.

If organic substances are ever excreted in forms injurious to the plant, they cannot long remain so; for the processes of decomposition would soon bring them into a wholesome state.

Every farmer who adopts a system of rotation should adhere strictly to it, and not be often tempted to take two exhausting crops in succession as soon as his land begins to improve. If extraordinary circumstances render such a course advisable, he must remember that this departure from the proper course can only be repaired by extra liberality in his treatment. The remark of Boussingault in par. 5111, though with reference to a more purely scientific view of the question, may be applied by the practical farmer. "He should establish a kind of account current between the inorganic matter of the crop and that of the manure." So far as his knowledge of the mineral constituents of his soil goes, he should endeavor to more than balance the exhaustion through crops taken away, by means of manures added. With regard to the organic parts of the crops and manures, he cannot in the present state of our knowledge calculate quite so exactly, but may even then approximate sufficiently near to the truth for most practical purposes.

5113. I cannot leave this part of Mr. Stephens's work, without a few words upon the fertility of soils, as commented upon here. I do not agree with the view of Liebig thus adopted, that we cannot, at least in most instances, tell to what the fertility of the soil is owing. On the contrary, I maintain that in nine cases out of ten a careful analysis will at once show the causes of fertility or barrenness in a soil; and if at the same time the physical characteristics are taken into con-

sideration, together with all points relating to season, climate, and course of cropping, light may be thrown on the most obscure cases. I say this without hesitation, as I think that even my own limited experience has given me sufficient proof of the fact. That there are cases not only beyond my power of explanation, but beyond that of the most eminent scientific men, I readily admit: but I believe them to be in the minority, and that even these will in time yield to persevering chemical analysis. If the chemist, after years of labor, cannot at the present day say, in most of the cases that are submitted to him, what are the ingredients or combinations that cause fertility, the science of scientific agriculture is in a far more discouraging state than I suppose it to be.

I know that the failures on the part of certain schools, in the application of their ready made theories to practice, have been quite decisive, and also know that discouragement has been the result; but that is no reason why other theories, founded originally on practice, should not succeed, and have not succeeded. To fit practice to theory is one thing, and to fit theory to practice is an entirely distinct, more useful, and successful business.

It seems to me quite certain that the atmosphere as such, has a decided share in the fertility of the soil, although its influence is modified by the prevalent temperature and character of the climate. I do not see why we may not as well say that the constituents of the soil as such have no share in its fertility, because a soil in Nova Zembla does not produce as much as a soil of exactly similar constitution in the Antilles. The elements of fertility are in both, so far as the soil is concerned, and so far as the surrounding atmosphere is concerned, but the climate causes the difference. Now to say that temperature is the controlling agent of fertility, as many might be supposed to do from this statement, would, as I conceive, be falling into the same error which I am combating; all the warmth even of a tropical sun fails to make the African deserts fertile, for there water is needed and becomes in its turn the essential condition.

We may carry this reasoning still further, and show that by simply altering the chemical constitution of the atmosphere, we may neutralize the combined influences of the best soil, the best climate, and the most justly graduated supply of moisture in the world. Thus it turns out that no partial view of the case is a correct one, but that the atmosphere, the soil, the climate, and the supply of water, all have an indispensable part to act.

There are many points yet to study with regard to their combined action; but I believe that we are acquainted with the leading

principles that regulate their bearing upon any given locality, and I am not afraid to say boldly, that the well instructed agricultural chemist of the present day can, in almost every case, derive much valuable information from the mere analysis of a soil; and provided the other facts as to climate and physical character are given, can pronounce with confidence not only as to its fertility and barrenness, but as to the kind of crop and of manure best adapted to its condition.

5116. The experiments by Professor Way, alluded to in this paragraph, are of much interest, and have opened a new field for chemical research. They appear to explain quite satisfactorily some points which have been obscure with regard to the different action of manures on light and stiff soils. In the concluding paragraph from 5119, are given some facts that of themselves correct many of the inferences that might be drawn from the views of Liebig, to which I have alluded; for here we see that practice has learned to proceed, and successfully too, upon the assumption that analysis does afford some certain ground to stand upon. We see analyses of crops brought to bear directly upon those of the soil, and see moreover that the two cannot well be separated in practice, for they are in a great degree mutually dependent each losing a part of its value when alone. We cannot from the nature of the case represent the constitution of a soil as exactly as that of a plant, but we can come sufficiently near to connect the two for all practical, if not for all scientific purposes.

5147. *On the Management of Fowls.*—This is a department to which I am conscious of an inability to make any useful additions. The information given is all of a practical character, and it is quite clear that Mr. Stephens, although interested in the subject, has not yet arrived at what may be called the romance of fowl-breeding.

He is perfectly able to write calmly about a hen, without running off into a fit of enthusiasm as to the Cochin Chinese, Shanghai, Poland, Dorking, or other breeds. His tone is, I fear, not elevated enough for our Eastern friends, and I apprehend serious complaints from them. He certainly is open to the charge of having dismissed this most important department of fancy agriculture, with a comparatively slight notice.

Realization or Sequel.—This portion of the work is mostly an enlargement of the old edition, and contains much new matter. I shall follow Mr. Stephens as through the previous parts of the work, noting here and there points to which I conceive particular attention should be given.

The directions and suggestions in the first twenty pages of this part, relative to the physical geography of land, differences of climate,

and modes of judging land, are all important, and may be in many ways useful to our farmers as the accumulations of experience. In our New England and Eastern States generally, climate is an especially necessary consideration in selecting a farm. In such an uneven, broken country, the choice of situation is of great importance. The direction in which the slope of a hill side faces, may make a practical difference of vital effect in the cultivation of the most valuable crops. In the valley and on the hill may be a difference amounting even to a week or two in exemption from early or late frosts, and leading to a corresponding difference in the success of the occupants. Such illustrations as these show us the justice of the observation in paragraph 5237, that the mean temperature of a place is not a sufficient index to the character of its cultivation, unless we have the extremes also. For example, the mean temperature in New Jersey, Connecticut, New York, and New England, does not vary greatly in its range from Edinburgh, Dublin, and London, that is from 46 to 52; and yet we are able to grow crops which they cannot ripen at all, while at the same time they plough and sow when our ground is yet frozen hard. Their climate is more equable, being neither intensely cold in winter nor warm in summer; ours is in extremes, so that the heat of our summer more than makes good the cold of our winters.

5247. As the importance of drainage becomes more generally recognised, due weight will be given to the remarks in this paragraph as to its influence on the permanent temperature of the soil, by withdrawing any excess of moisture. This bears with particular force on a class of soils that our farmers call cold and sour, but which they generally consider it quite unnecessary to drain. Such land has an excess of water, which keeps down its temperature; when that is removed by the drain, the temperature will rise, and the properties of coldness and sourness disappear.

5259. It is I believe the general impression that in this country also our winters are usually less severe, and our springs more uncertain and backward, than formerly, and the reasoning of Mr. Knight upon the subject will attract attention.

5263. The judging of land from the directions here given is seen to be a study, and to be reduced to a matter of rules aided by practical skill. Particular attention is there paid to the subsoil, and with good reason, although it would I am sure be considered useless trouble by some of our old-fashioned skimming farmers. I fear too that the signs of exhaustion and low condition enumerated in p. 5280, would be found on too many of our long cultivated farms.

The information as to the estimation of

rent, mode of offering for a farm, negotiating the lease, &c., paragraphs 5284 to 5366, is not so applicable to this country as to many others, our farms being mostly in the hands of proprietors. Where farms are let, few if any regulations are usually adopted to bind the tenant to any particular course. The consequence is that, in very many cases the letting of a farm is an equivalent to a great and lasting injury of the land; for there are few tenants who, when holding land unrestrained for a short period of years, can resist the temptation to take a little more off than they put in. Some set themselves deliberately at work to exhaust the land within the term of their occupation. Such a state of things ought not to continue; the tenant should be bound to pursue a certain course, and that course to be one laid out by the landlord, so that his land could not suffer. The natural tendency of things is always to the accumulation of large properties, and as we become an older people tenants will undoubtedly be more numerous than they are at present. Whether this is desirable or not cannot now be discussed; I merely mention the probability of such a thing, that we may see here what would be the best management for the land in such cases.

5367. This minute account of all the expenses connected with a farm of 500 acres, during the first eighteen months of occupancy, is both curious and instructive. The sum of nearly \$18,000 laid out in so short a time, in merely stocking the farm and commencing operations, is a very large one, and shows the amount of capital required in British husbandry. When we add to this the cost of buildings, par. 5516, making some \$10,000 more, the whole outlay by the landlord and tenant is not less than \$30,000, without mentioning the farm house and the laborers' houses. Besides his \$18,000 of outlay, the tenant also has his rent to pay, which would vary from \$2,500 to \$8,000 per annum, or even more in some cases. It must be noticed, however, as one alleviating circumstance, that when we speak of a farm of 500 acres in England, it means 500 acres actually under cultivation; not half to three quarters woodland or rough pasture, as is usually the case with us. The farmer, by reading over the variety of advice and information given under these various paragraphs, may glean many items of a highly useful character. We may not follow such a system exactly, but we may perhaps derive much advantage from copying some of its parts and details. The prices of work, especially of that in wood, can be no guide to us. The account of Chubb's detector lock, with the 2,592,000 chances of security it affords, is quite refreshing, and I would advise all farmers to apply the advice which is given relative to locks to the purchase of all other articles;

the best is ultimately the cheapest; a half dollar or dollar saved in purchasing an inferior lock, may open your dwelling to the burglar and cause the loss of thousands; a dollar or two saved in the purchase of a plough, may throw horses and hands idle in the midst of pressing business, while the inferior implement is repairing; such is almost always the result of unwise economy.

5566. There is much under this head that is worthy of attention from our farmers, particularly those who occupy old farms. In many parts of our country very little heed seems originally to have been given to the shape of the fields, which are consequently found in a great variety of capricious shapes. These irregularities are doubtless picturesque, but they give rise to numerous difficulties in practice, and occasion a very considerable loss of time in extra turning. As near to a square as possible is, according to Mr. Stephens, the best form and the easiest worked.

5596. The planting of hedges or trees, and the placing of walls for the distinct purpose of affording shelter, has not been done to any great extent in this country, and yet I have no doubt but it would be found very beneficial in many localities, where cold and strong winds prevail during any part of the year. We frequently see in our wildest districts, farmers' houses perched upon the summit of bleak hills, without even a bush to break the force of winter storms. A thick clump of evergreens planted so as to break the force of the prevailing winds, would prove a great source of comfort in such a situation. In Scotland whole farms are sheltered and greatly improved by judicious belts of plantation; they are made more healthy to animals, and earlier in ripening crops. The hedges, which are so common a mode of inclosure in Great Britain, form an excellent shelter, and a most durable fence if properly cared for. Without care, however, they soon become defective and straggling plants die out, the gaps are stopped by two or three sticks or a bush, and finally the hedge, in such a dilapidated condition, looks worse than any other kind of fence. The hawthorn does not bear our summers well, but we have a variety of native plants that form an equally handsome and strong hedge. The great point is to keep the plants cut down low for the first few years after transplanting, so that they will thicken at the bottom, and afterwards to give them an occasional clipping. Gaps caused by a dead plant, or any other cause, should be at once attended to. All the necessary minutiae of planting, forming banks and ditches, are fully gone into under this head, and will, for the most part, apply to the formation of hedges in this country.

I do not see that the dead hedge, fig. 468, or the stake and rice fence, fig. 469, possess

any properties which recommend them on this side of the Atlantic. A stump fence is far more picturesque and durable; and even the crooked fence might almost compare advantageously with these. In our Eastern, and all other States, where wood is cheap, it forms the least expensive and troublesome fence that can be made; but where it begins to grow scarce, and on the Western prairies where there is none, some substitute must be found. I am inclined to think that in all such regions hedges will become rather common, though it is not probable that they will be attended to in the careful manner here described. Wire fences, if strong enough, may very possibly supersede all other kinds in many sections.

5692. In the New England States we consider ourselves beyond all teachers in the art of building stone walls, and consequently are not prepared to acknowledge the receipt of much information under this head. The plates and directions will be found more useful, in those States where stones do not usually cover more than half of the surface. Our walls generally lack the coping shown in fig. 476, partly however for the reason that being in a region of boulders, we seldom have such regularly stratified stones to lay as those shown in the cut. Where they can be procured the coping is of great service, as it keeps the upper courses of the wall in their places, prevents walking upon the top, and makes the wall a better barrier for sheep. I have often seen this coping laid in mortar while travelling in Scotland.

5722. I do not know that the methods of setting up and straining wire fences here given, differ much from those which are described in our own agricultural papers, and therefore do not linger upon them. The cheapness of wire and iron in England gives them an advantage in the construction of this kind of fence: but I think with Mr. Stephens, that it is doubtful if it ever supersedes hedges, or stone and wood, for situations where great strength is required, or where shelter is necessary.

5755. I might probably, by searching over agricultural periodicals add designs of some hundreds of gates in addition to those figured here; but as they are almost all defective, think it best to be content with these. We have, however, some very ingenious gates, which seem to me fully equal to any of the plans here described. The great difficulty with the ordinary field gates is, that in our northern climate they are liable to sag, the heel post being thrown out of the perpendicular by the frost, if not by the weight of the gate itself. This is an annoyance which is comparatively little felt in Britain, but is very serious here. It is this which has led to retaining the clumsy *bars* on so many of

our farms; they are troublesome, and make a good deal of work in taking out and putting in, but they are always in their place and not liable to get out of order. The heel post of a gate should be sunk deep and firmly wedged, and the gate itself so hung that its weight shall not all hang from the top of the post, but rest chiefly on the lower hinge. This may be managed by means of the diagonal braces.

5774. The recommendation here given for the preservation of gate posts is useful, and might be followed with advantage. It would be still better to get a post Kyanized or Paynized, according to one of the processes now in vogue, by means of which it is said to be rendered almost as indestructible as stone.

5775. *On the Draining of Land.*—Under this head the American farmer is presented with the most complete practical and theoretical system of drainage that I have yet seen; the account is full, particular, and clear, and is illustrated sufficiently to render every detail intelligible. Now that draining is beginning to assume an aspect of importance in this country, the present treatise is particularly appropriate, and will doubtless be studied with much interest.

In pars. 5778, 79, and 80, are announced truths which I have many times presented to practical men in various States, but which are usually received with some incredulity. It is difficult to make the farmer whose land is tolerably dry on the surface, believe that there is too much water beneath. This is nevertheless the case on numerous farms, and no way short of thorough draining can be found to render the grass on such fields other than cold and sour, or the crops other than yellow, sickly, and scanty. These soils may become dry at midsummer to a proper depth, but they have been wet through all the early part of the season, when the crop should have been growing, and very probably now, when they are dry, they have baked hard and stiff. At the close of par. 4780 Mr. Stephens announces his conviction that there is not a single farm in the kingdom of Great Britain, that would not be benefited by draining. This seems a strong statement, but I am aware that other experienced men have said the same thing. I do not think that such an assertion would be made by any prudent man regarding this country, where our climate makes a great difference in the dryness of the soil. There are many districts where the drain, even if it produced any improvement, would certainly not repay the cost of its introduction. But at the same time I am surprised to find, in travelling through different sections, how few farms there are, some parts of which would not be improved by drainage. After a little practice the eye can select these spots, almost as far as the nature of the crop is discernible. I have seen, while travelling through the coun-

try, thousands and tens of thousands of acres rendered cold and unproductive in a more or less striking degree by this concealed water, of the existence of which it would be very hard to convince the owner.

On our farms, according to my present impressions, drainage will require to be on a more limited scale than in Britain, and it will not therefore be necessary to talk of draining every field. The operation will commence at least, with those parts of the farm which are beyond all question too wet, and gradually progress as experience and practice prove its efficacy.

5788 to 5793. The directions here given as to levelling are immediately practical, and show that it is practicable to drain land with a much less slope than is thought possible here. In fact there is no place where the natural water runs off at all, in which fall enough for a tile drain cannot be obtained. When the fall is so gentle, the outfall or outlet must of course be particularly attended to as described in par. 5791.

5795. The advice given relative to neatness of cutting is quite necessary, as is also the caution to lay the tiles or stones, and fill up the ditch, as soon as possible after it is cut. Any one who has seen the effects of a heavy shower on the sides of a newly cut ditch, will understand the extra labor that may be incurred by a little neglect in this particular.

5799. The principle here laid down, that the small drains should be carried straight down the planes, irrespective of wet and dry spots, is one that has been thoroughly established by long experience as the best. All practised drainers have discarded the old system of running the drains round the edges of hills, in order to cut off the springs; they hit them all the more surely, and dry the land more completely, by following the other system.

5803. Nothing is more true than that by stopping a foot short of the proper depth for a drain, money is lost; there is a small apparent gain, or rather saving, at first, but afterwards there is an annual loss of manures, and also loss in the inferior crops. If such an improvement is to be made, the best policy is to do it well and permanently, not to follow such a mistaken course as did the Lothian farmer mentioned in par. 5804, who by saving in the number of his drains, flattered himself that he was drying his land very cheaply, whereas the event proved that he was only able to get a good full crop from about half of the field; the whole operation was an illustration of the old maxim, penny wise and pound foolish. I am inclined to think that most of our light soils may be drained by three feet drains, at from thirty to fifty feet apart, but on stiff soils they must be much nearer together. Probably there are very few

cases where a depth of less than from thirty to thirty-six inches is advisable, and I am inclined to doubt if there is in most localities much advantage in going beyond that, although some of the later English authorities talk of going as low as seven feet. Three feet in depth will leave an available working soil of 30 inches, which is six or eight inches more than has ever been attained by the most powerful subsoil ploughs, or even by the fork. I am not sure that the benefit of going down further would repay the greatly increased expense.

5812. The narrow drain spade, fig. 496, and the scoop hoe, fig. 479, and also those of figs. 508 and 509, would be valuable implements for use in this business of digging drains. It is in this point that our farmers will encounter most trouble at first. They will not have the proper tools, and may not be able to find men who have been accustomed to ditching. An expert ditcher will do very nearly twice as much as one who is unused to the business, and at the same time in a neater and more workmanlike manner. The better way is to have them done by contract, at so much a rod.

5837 to 5847. We here have figured all the various forms of tiles that are worthy of notice. The pipe tiles have come into universal favor, because they are so much cheaper than the old form, where there were two pieces, the tile and the sole, requiring to be made at separate operations of the machine. Their superior lightness too is an item in transportation; and from their solid continuous form, they are much less liable to be broken. I have no doubt that Mr. Stephens's views relative to the proper shape for a pipe tile are perfectly correct, and that fig. 515 presents more advantages than any other form. The objection to this and all forms of tiles in the minds of our farmers, arises from a fear that water will not find its way into them; but surely the experience of all Great Britain should be sufficient to weigh against a mere individual prejudice. The fact is, that nothing short of surrounding the pipes with some water-proof concrete, will keep the water out of them. No packing of clay, however stiff, will do it for any length of time. As to their capacity for carrying away the water, Mr. Stephens observes, par. 5847, that, from his experiments, a pipe of one inch bore is quite sufficient to carry off all the water that falls within the range of its action. In 5850, the principle by which the tile dries the soil, and in consequence of which it is almost impossible to keep the water out of it, is clearly explained. Stiff clay is really the best substance for the immediate covering of the tiles. If, however, the first season after they are laid in a heavy clay soil is a very wet one, the full effects of

the drain are not perceptible until the second year.

5852. The cost of draining with tiles, as given in this and succeeding paragraphs, is really very trifling when compared with the benefit, and the actual increase of value arising from the operation. It cannot, however, be a standard for us. The cutting of the ditches is done far cheaper than in this country, and the price of tiles is not more than a third of what we have to pay at present. There are now but few machines making tiles among us, so few that the demand is greater than they can supply. In consequence of this the price keeps up, but will fall when competition fairly commences. As an illustration of English prices, I refer to Mr. Mechi's experience, in par. 5852, where the cost of digging a four to five foot ditch was only six pence, or about twelve cents, per rod, and the tiles about \$3 per thousand, making the whole expense of draining an acre but about \$12.

5856. I could add quite as remarkable statements as any here given, drawn from my own notebook while travelling in Scotland and England; the general testimony of the farmers was, that they got their money back in from two to three years; many got it back from the first crop.

5862. I have seen an instance where this deposit of iron ochre was so abundant, as to choke tile drains within twelve months after they were laid. A strong stream of water sent in at the upper end of the drain washed it out in large clots.

5879. I would recommend those of our farmers who make stone drains, to read over this and the succeeding paragraphs on the same subject. Our stone drains are very generally made with large stones, so that small animals can obtain access, and so that earth can wash in; the consequence is that they are extremely liable to choke, and when choked, their repair is both troublesome and expensive. The breakage of stones, as for a macadamized road, is a tedious and expensive business, and it might be easier in many places to screen out a coarse gravel for this purpose. When tiles can be obtained they are I think cheapest, even at present prices. Where stones must be used, they should, in accordance with the present directions, be as small as can be got, and the filling should be very carefully done, so that no more water may obtain access at the top than would fall naturally on the portion of earth immediately over the drain.

I heard Mr. Smith, of Deanston, the leading originator of the present system of thorough draining, say that he had stone drains twenty years old on his farm, doing as good service as when they were first laid. I

am quite sure that the plan shown in fig. 524 is a good one for stone drains; flat stones can always be found to make the triangular channel, and the small stones at the sides and on the top are an effectual protection against the burrowing of animals or falling in of earth. Especial care is necessary to keep the top of stone drains well below the lowest reach of the plough; for if it touches the upper stones and loosens them, earth will certainly wash in and cause a stoppage.

5895. It might be supposed that the shouldered bog drain, fig. 530, would soon collapse and close, but this is not the case. When a true peat is exposed to the air it hardens and dries; if after exposure for a month or two it is again immersed in water, it does not become soft as when it was first cut, but remains hard. The peat tiles, fig. 533, are almost indestructible. I saw one which had been thrown into a steam engine boiler, and allowed to remain for several weeks; on being taken out it still retained its shape and hardness, without any material alteration.

5932. The reading of this and two or three subsequent paragraphs, with the examination of fig. 541, will be useful to those who still remain unconvinced as to the ability of pipe tiles to form a successful and permanent drain.

5937. I should suppose that in some parts of our country, where the necessary materials are abundant and cheap, concrete tiles, such as fig. 542, might be made cheaply, and form a more economical drain than clay tiles at the present prices. They are not easily broken, and would last for an indefinite length of time.

The experiment detailed in par. 5941 shows the immense quantity of water that is drawn off by drains in a single season. It is easy to conceive that the effect of so large a body of water remaining, as it would for the most part have done, would be highly injurious. The very ingenious apparatus shown by fig. 543 might be applied with advantage to the measurement of any small steady stream, and would afford very interesting results.

The subject of draining is one of such magnitude, that I might extend my notes in this department to very many pages, but the space at my command will not permit me to do so, and I must leave it with the foregoing brief suggestions and commentaries.

5949. *On Improving Waste Land.*—It is very generally the custom in this country, when ploughing for the first time land that is stony and full of roots, to use a heavy plough, with oxen instead of horses. They move more slowly, and do not suffer so much from being brought up suddenly. It must be acknowledged, however, that the first year's operations do not usually leave such land in a highly finished state; the work is slow and

toilsome, and after all the soil actually moved by the plough is of a very uneven depth. The farmers generally rely upon the ploughings of subsequent years to improve the surface further.

This is unquestionably an inferior system compared to that of trenching all these stony and tangled plots; but in many cases it is the best that circumstances will admit. On much of our new land the cost of trenching would amount to many times the first price of the soil itself, and to far more than the value of its produce. Here then the only course obviously is, to tear up the surface in the best and most economical way possible, and to improve upon this imperfect operation in every subsequent year. In the older States more expensive operations are practicable, and even advisable. I have known from \$50 to \$70 per acre spent in the digging, blasting, and carrying away of stones, and with profitable pecuniary results. On some long cultivated farms, however, this business of getting out stones is neglected as being too expensive, and we may see stones scored and seamed in every direction, with the marks of the ploughshares and harrow teeth that they have blunted or broken. I have no doubt but stones might be found on some farms, that have thrown out the plough for fifteen or twenty successive years. It is said by some farmers that a large and hard boulder is easier got rid of by sinking it a foot or two, than by blasting and carrying away the fragments.

5977. *Trench and Subsoil Ploughing.*—The subsoil ploughs mentioned and figured here, are more costly and weighty instruments than those lately introduced here. They are calculated to go deeper, and to be drawn by a larger power, than any that I have seen used in this country. Our subsoil ploughs are comparatively light and cheap, and are mostly intended for use on small farms where the team available for working them is small. They are extremely valuable for such a use, even if they gain only two or three inches on the furrow of the ordinary plough. The next time of using they will go an inch or two deeper still.

The benefit derived from the employment of these small ploughs is very generally acknowledged by those who have used them, and they will in time give way to heavier implements. All that have become interested in this method of improvement, will find much that is instructive under this head.

I have never seen what might properly be called a trench plough used in this country, but am quite sure that it would be found of great service on some classes of soils. All of these operations are, in the present state of our agriculture, only applicable to the older districts of the country, and to those who have a very ready access to markets. In

many parts of New England subsoiling or trench ploughing to any great depth is wholly impracticable, on account of the stones and rocks which abound so as in some cases almost to form a species of pavement. The removal of these previous to trying such instruments is absolutely necessary, but would certainly not pay except in some districts that are very favorably situated. The practical experience of Mr. Stephens with regard to the effect of bringing up the subsoil to the surface, as given in paragraphs 5988, 5997, and 5998, is of much value, and yet I think that I have seen soils where the turning out much of the subsoil at any one time could not be considered advisable. I have known one or two cases where soils were ruined for several years by injudicious trenching. The application of common sense will suffice to prevent such failures in the majority of localities.

6046. *The Forming of Water Meadows and Irrigation.*—The results obtained by the formation of such meadows have been in many instances most extraordinary. There is no water derived from springs that is absolutely pure. It all contains some mineral matter and some organic matter, made up of substances varying with the sources of the springs, and the composition of the strata through which they pass. In passing over and among the roots and stems of living and growing plants, the water parts with at least a portion of these substances for the benefit of the plants. Thus from the purest spring water, plants derive so much nutriment as to become healthy and luxuriant.

Such meadows would be eminently of service in dairy districts, where the pastures are apt to fail in midsummer; a little cutting from them once or twice each day would keep the herds in condition. They would also be highly valuable in all places where it is difficult to procure hay enough for the winter stock. Where water can be procured that has run through sewers, or into which large sewers discharge, the effects are perfectly astonishing. The celebrated water meadows near Edinburgh, that rent at from \$50 to \$60 per acre, are of this class. The grass is cut from them at short intervals during the whole season, a mowing taking place I believe between each crop.

The details as to the cutting of ditches, and the distribution of the water generally, are sufficient guides for practice. Careful attention is requisite in the management of the water while flowing, and in its equal distribution. It must also be seen that the plants are not flowed too long, as that would result in their injury.

We could not in this country irrigate during the months of December and January, as recommended by Mr. Stephens, par. 6064, but

would have to do a part of it in spring. Irrigation cannot be expected to produce very remarkable effects upon land that has a close retentive subsoil and is undrained. An irrigated field should, naturally or artificially, be so drained as to become dry almost immediately after the flow of water is stopped. The riches deposited by the water then become entirely available for the growing grass, and the soil warmed almost immediately by the sun, exhibits a surprising degree of fertility, when we consider the seeming insignificance of the means by which it has been produced.

On the Treatment and Training of various classes of Domestic Animals, on Slaughtering, and on the desirable points in Stock of all kinds.—Paragraphs 6076 to 6282. I have included all the matter treated of under these heads in one comprehensive caption, because I am aware of my inability to add anything of particular value to the details and illustrations here given. The opinion of any experienced stock breeder on most of these matters would be worth more than mine, as my studies have been directed in other channels, and I have already called attention to some of the more important chemical points connected with the feeding of stock. Paragraphs 6193 to 6282 include, as it seems to me, a most valuable and comprehensive treatise on the forms, qualities, and peculiar excellences of the various kinds of live stock. The illustrations are uncommonly characteristic, and the whole outline of this subject as worthy of study by the American as by the English farmer. The laws of breeding, and the principles of crossing, as explained here from the results of extended experience, will also demand close attention.

These branches of improvement have probably been of late more attended to in this country than any others, and consequently more advances towards a state of perfection have been made.

We have at least specimens, and in many cases widely diffused herds and flocks, of the best foreign breeds. Animals of undoubted pedigree and of real sterling excellence, may often be seen on farms that otherwise show marks of most slovenly and imperfect cultivation.

My own opinion is, and I believe myself to be sustained in it by many practical men, that in our stock we are, as a general rule, in advance of our cultivation. We have brought up its character, and this is well; we should continue to improve it farther; but at the same time we should remember that the stock department is after all only one of those that require attention and diligent effort. From want of consideration in this respect, much of the foreign stock imported has deteriorated, even where it has not

been crossed and mixed. These highly bred and highly fed animals will not thrive as they do at home, when turned out to seek a living on poor, worn out, neglected pastures. The good farmer should improve his stock, but at the same time must endeavor to make his land equal to it.

Those which are called *native* breeds here, and which are cited by some farmers as showing the inutility of importing foreign stock, are beyond question descendants of stock imported by early settlers. They have since been mixed in various ways with other breeds, so as in time to form a species of distinct individual character.

6283. *On the Living of Farm Servants, and of Wages.*—Under both of these headings much will be found that differs from our system. Our wages are greater in amount, and usually paid by the month. There are no markets set apart for the hiring of laborers, and from the want of this facility the farmer is frequently put to much inconvenience in hunting up hands.

6335 to 6381. The observations on this subject, included in these paragraphs, are both important; the one to the neatness of a farm, and the other to the accuracy of any experimental researches that may be made. Many farmers buy expensive implements, and leave them exposed during the winter; the same sort of careless persons are constantly making experiments, which, for want of the proper precautions, are almost totally useless, or even in some cases worse than useless, on account of throwing doubt upon really correct views.

6382. Of corn markets we know little as yet, but I think it probable that they will ultimately be established among us.

6404. *Of Farm Book-keeping.*—Such a system of accounts as is here explained, or any really well arranged plan, would save the farmer much perplexity, and frequently much

actual loss. There are comparatively few farmers who really know exactly how they stand, or who can show in figures the real state of their expenses, profits, and losses, for a whole year. If they kept strict account it would be easy to look the matter in the face, and see just what procedure was most advantageous and economical. It is not essential to follow the examples given here, if the farmer can invent anything better. I have known one or two farmers who had devised admirably simple and comprehensive plans of their own, which presented the whole actual state of affairs in any one field, or on the whole farm, at a glance.

I have now arrived with Mr. Stephens at the close of his arduous task, and have only to say in conclusion, that so great have been the variety and fertility of the topics presented by him, that my great difficulty has been to make a selection among them. Confined by the size of the original to narrow limits in my additions, I have endeavored to touch upon those points only which seemed to be best calculated for the illustration of the wide differences which undoubtedly exist between American and British agriculture, and for the pointing out of the ground which may be considered common to both countries. It is not to be supposed that this or any other work will reconcile or do away with all these differences.

Climate and the constitution of society, will always lead to the adoption of systems, the details of which are somewhat widely apart, but at the same time the general principles which regulate both will be found to approximate in a marked degree. It is to these general principles that I have for the most part endeavored to draw attention, and in view of them say confidently, that the American farmer may find in these volumes an ample, abundant, and invaluable store of information.

